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THE GULF STREAM MEANDERS EXPERIMENT. CURRENT METER AND ATMOSPHE--ETC(U)
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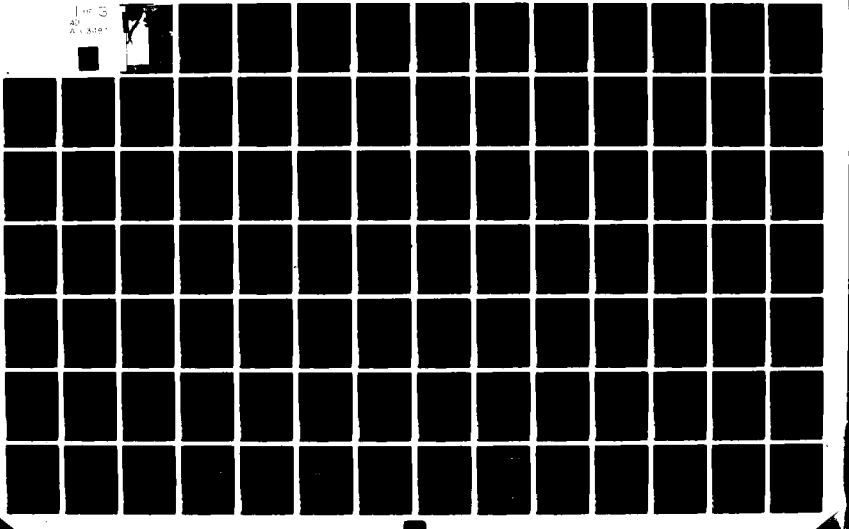

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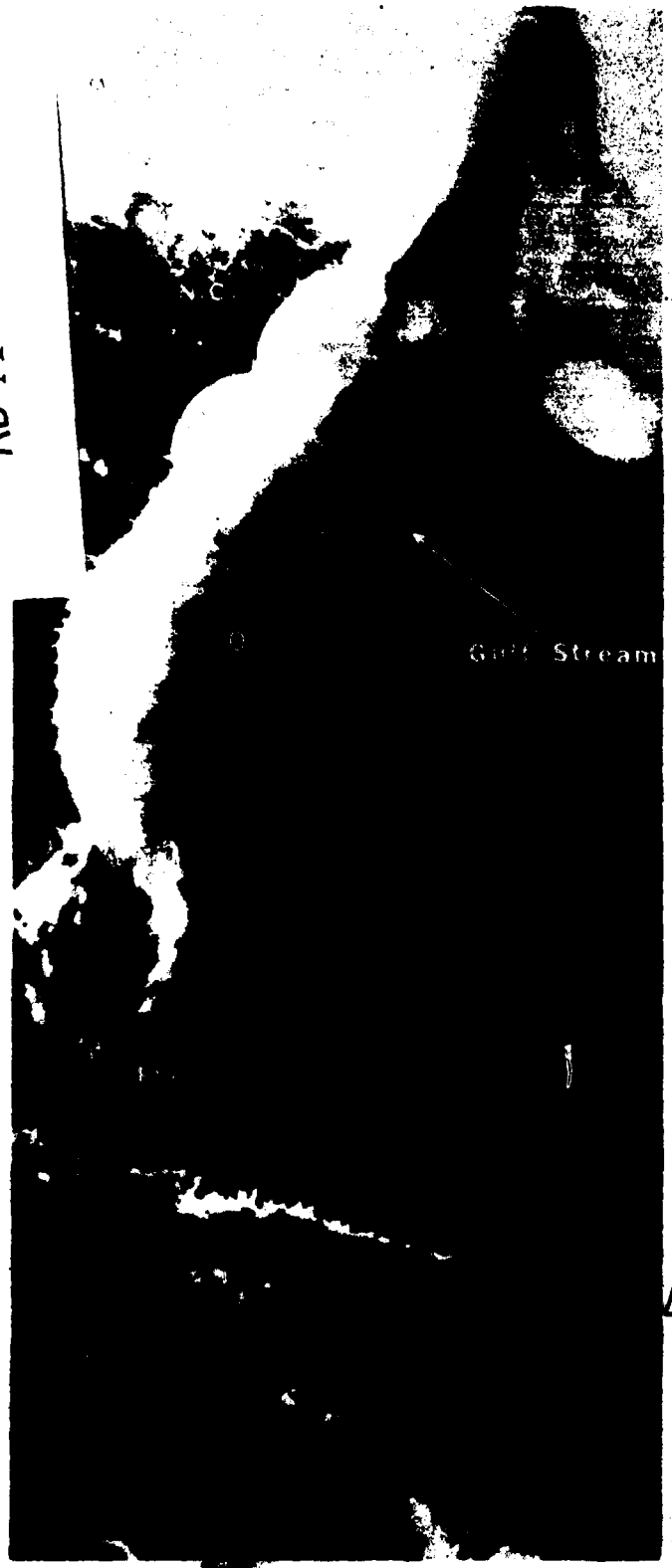

THE GULF STREAM MEANDERS EXPERIMENT

Current Meter and Atmospheric

Data Report

for the August to November, 1979

Mooring Period

by

David A. Brooks

John M. Bane

Robert L. Cohen

Paul Blankinship

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Texas A&M University

Reference 81-3-T

May 1981

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THE GULF STREAM MEANDERS EXPERIMENT

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[1] University of North Carolina at Chapel Hill.
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FOREWORD

This is the last in a sequence of data reports from the Gulf Stream Meanders Experiment. The field phases of the experiment were implemented as a joint project of principal investigators at Texas A&M University (DAB), and at the University of North Carolina at Chapel Hill (JMB). The complete set of reports is:

1. Hydrographic Data Report, EN-031 (Jan 79) and EN-037 (May 79). TAMU Technical Report 80-1-T, January 1980, 145 pp.

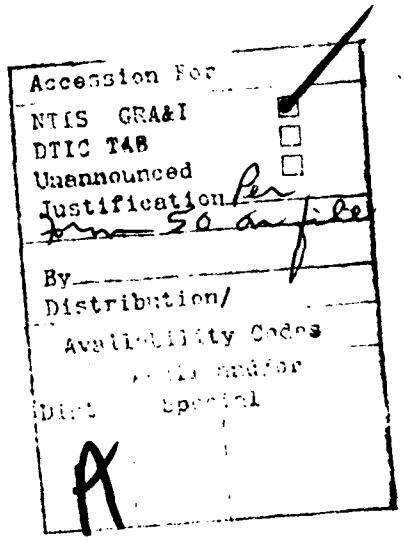
2. Current Meter, Atmospheric, and Sea Level Data Report for the January to May 1979 Mooring Period. TAMU Technical Report 80-7-T, July 1980, 264 pp.

3. Hydrographic Data Report, EN-040 (Aug 79) and EN-045 (Nov 79) TAMU Technical Report 80-10-T, September 1980, 170 pp.

4. Current Meter and Atmospheric Data Report for the August to November 1979 Mooring Period. TAMU Technical Report 81-3-T, May 1981.

5. AXBT/PRT Data Report, 9-18 February 1979. UNC Technical Report CMS-80-2, December 1980, 213 pp.

6. AXBT/PRT Data Report, 21-29 November 1979 UNC Technical Report CMS-81-2, April 1981.



Contents

List of Tables

List of Figures

SECTION 1

Setting and Design of the Experiment

1.1 HISTORICAL ASPECTS

The principal objective of the Gulf Stream Meanders Experiment was to kinematically and dynamically describe the nature of meanders. The upper continental slope region off Onslow Bay, North Carolina ~~(inset box, Fig. 1)~~ was chosen for the experiment site because several previous investigations in that area provided a baseline data set giving some ideas about time and space variability scales within and a several-month mean view of the Stream. ~~(Webster~~, 1961a, b; Richardson, *et al.*, 1969). In addition, earlier observations ranging from reports in centuries-old ship logs to recent satellite infrared imagery made it apparent that Gulf Stream meandering was more intense between Charleston, South Carolina and Cape Hatteras, North Carolina.

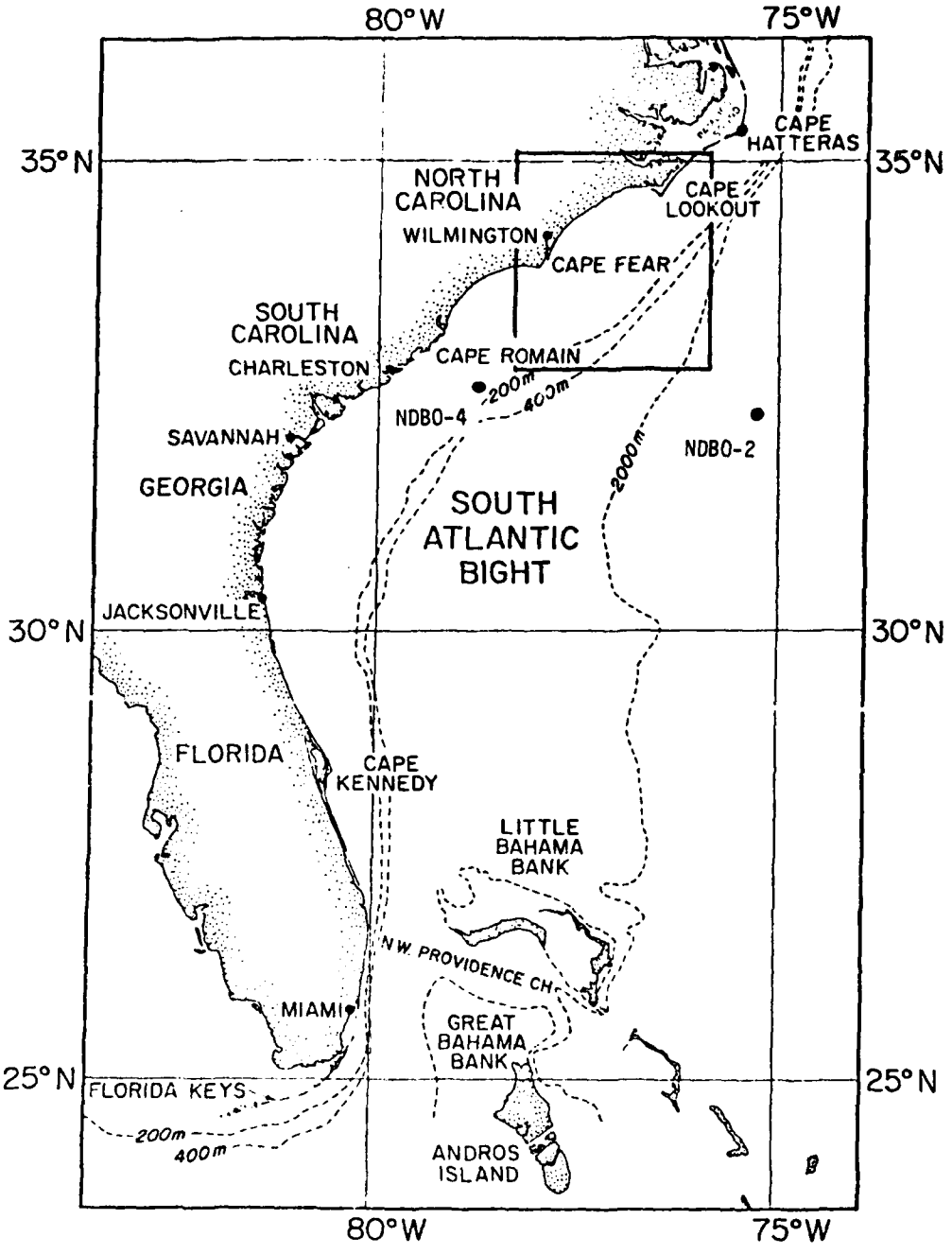


Figure 1. Map of the South Atlantic Bight, showing the location of the Gulf Stream Meanders Experiment (inset box). Atmospheric data from moored NOAA buoys NDBO-2 and NDBO-4 and from Cape Hatteras are shown in this report.

1.2 THE MOORED INSTRUMENT ARRAY

Averaged over two months, the Gulf Stream current speed on a section perpendicular to the topography off Cape Fear shows a broad, surface-intensified core (Richardson, *et al.*, 1969) extending over most of the upper continental slope (Fig. 2). Viewed on shorter time scales, however, the Stream core may be much narrower, with surface speeds considerably higher than those shown in Fig. 2. The Stream core wanders laterally over the upper slope with excursions of tens of kilometers (Webster, 1961a). Such a dynamically active region poses severe practical constraints on an experiment employing moored instruments, because the intense and highly variable current forces tend to push moorings over in the water column. Drawing on previous mooring experience in the Florida Current (Düing, 1973), we decided to deploy an L-shaped array consisting of four high-tension, subsurface moorings, each supporting two or three Aanderaa RCM-4 current meters in the lower half of the water column. The array was aligned with the local topography, with the long (75 km) leg of the "L" on the 400 m isobath. For perspective, the two moorings forming the short (15 km) leg of the "L" are shown projected about 10 km upstream onto Fig. 2. The plan view of the array is shown in Fig. 3, which is a more detailed map of the region in the inset box of Fig. 1. Mooring "D" is shown displaced for clarity. Due to instrument malfunctions, no data were recorded by meters number 3345 and 3324 which were at the D MID and D BOT positions, respectively.

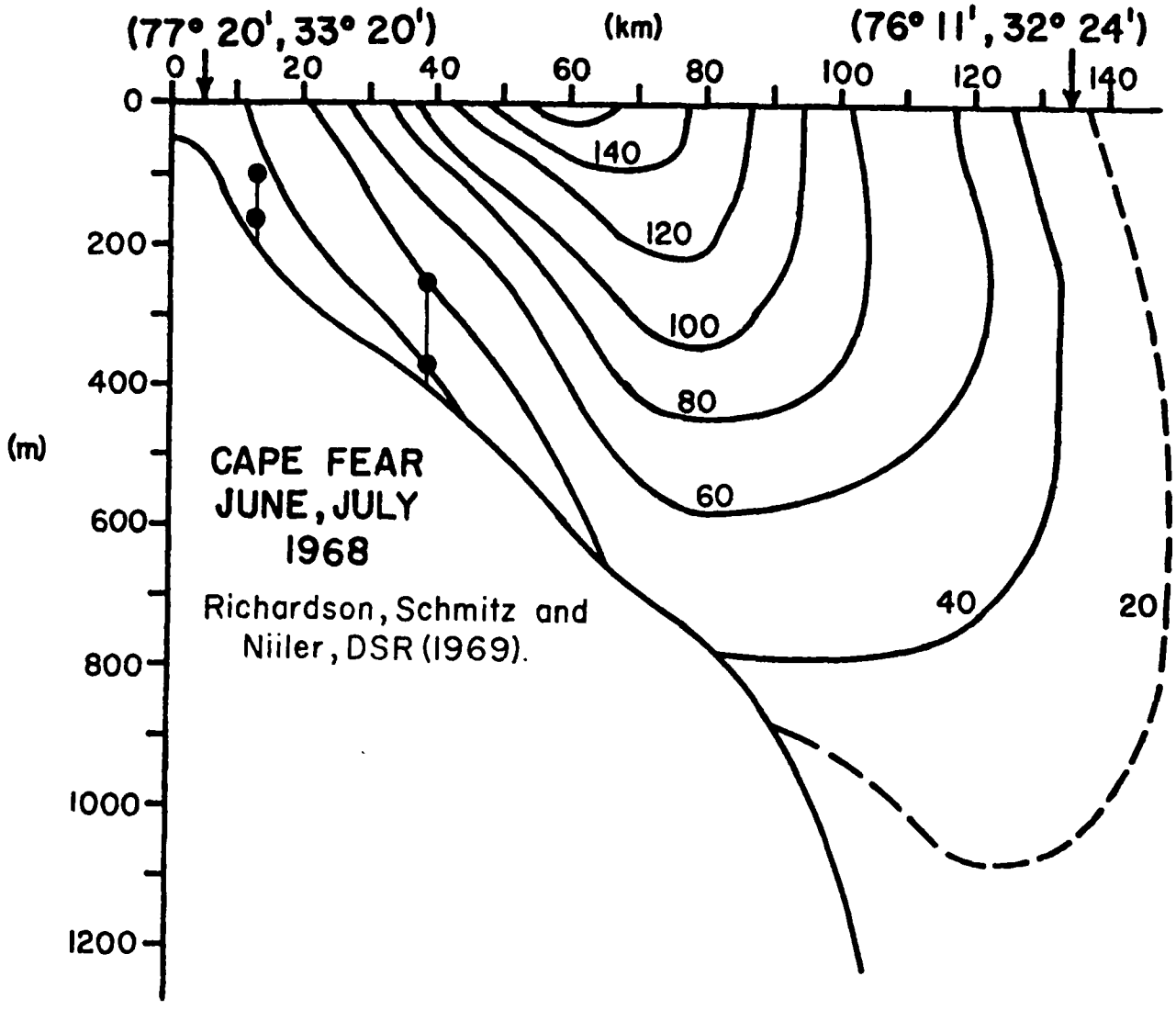


Figure 2. Cross-shelf section of the Gulf Stream off Cape Fear, showing two-month mean summer isotachs. The position of the A and B mooring current meters have been projected about 10 km upstream onto this section.

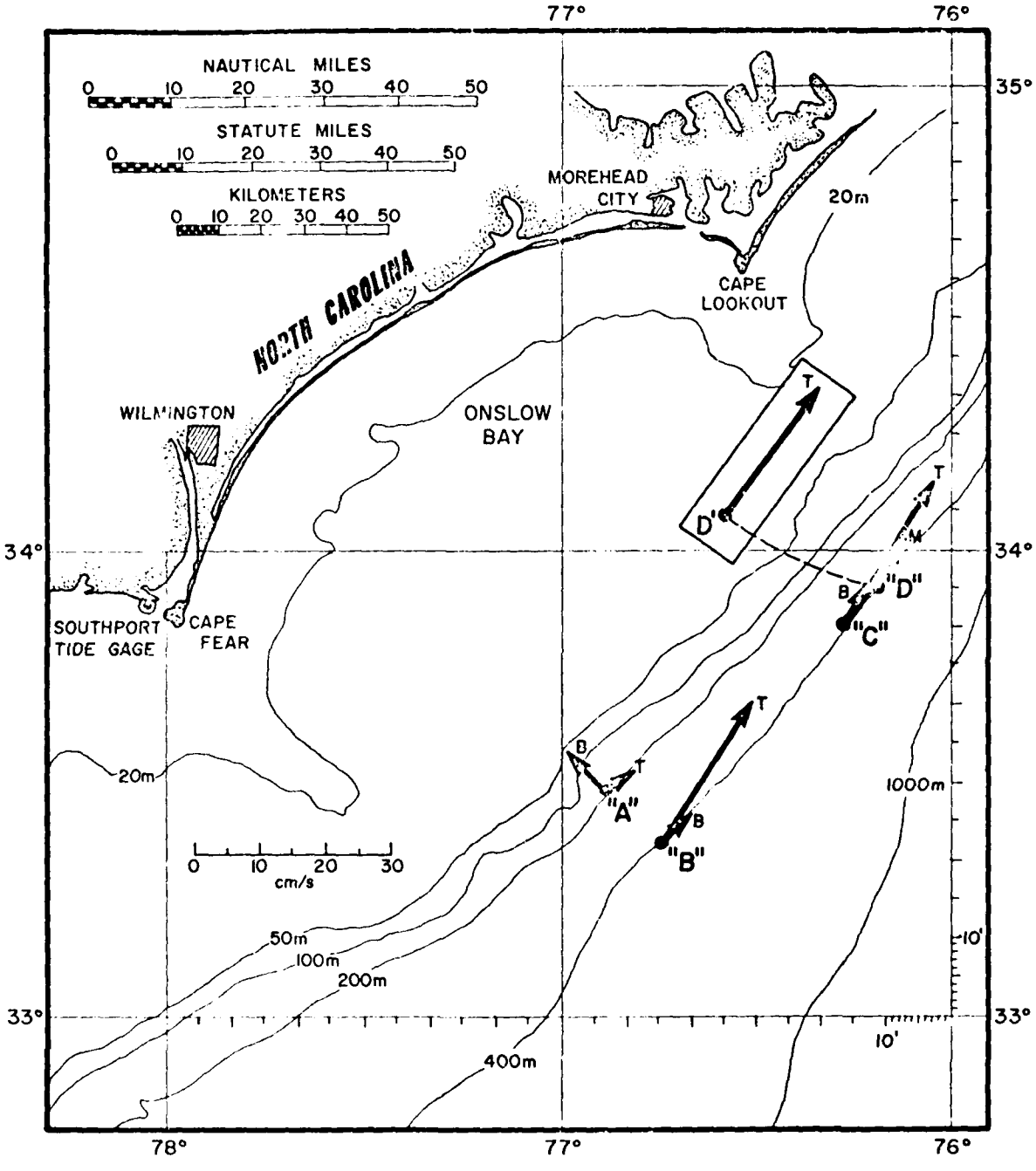


Figure 3. Detailed map of the experiment area (the inset box Fig. 1), showing the locations of moorings "A" through "D," with the record-long mean current vectors at the top (T), middle (M), and bottom (B) instruments. The mooring "D" position is shown displaced (inset box) for clarity.

Each mooring was supported by a single 37" (0.94m) diameter ORE float, yielding buoyancy in excess of 200 kg. The A and B moorings each supported two current meters, and the C and D moorings each supported three current meters. The vertical mooring design was similar to that given by Lee and Schutts (1977); a typical arrangement is shown in Fig. 4. The mooring coordinates, instrument start and stop times, instrument depths, and water depths are given in Table 1. The "summer" data set reported here spans the period from 03 August to 18 November 1979, or 107 days. Data from a similar experiment in the winter of 1979 are presented in Brooks, *et al.* (1980b).

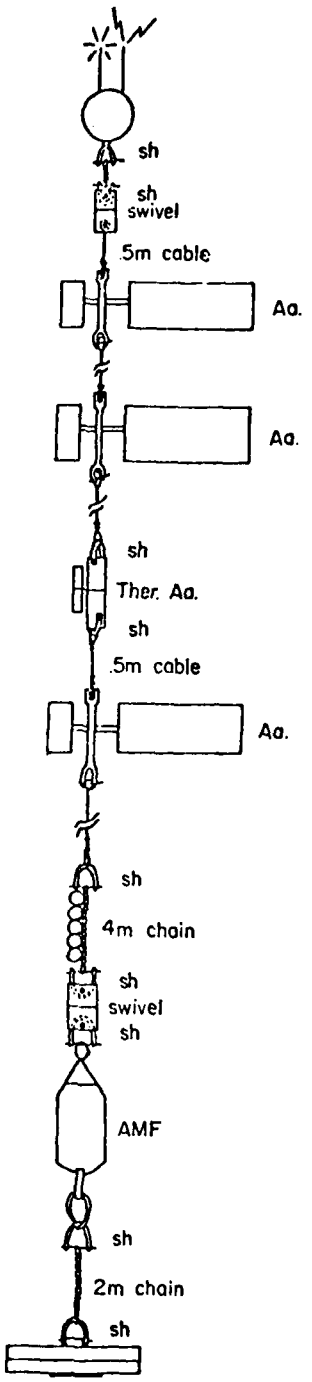


Figure 4. Typical mooring design, showing the position of Aanderaa current meters (Aa) in the wire held taut by a large main float and a train-wheel anchor. AMF (now EG&G) sea-link acoustic releases were used.

Table 1. Instrument identification, start and stop times, depths, and mooring locations.

Mooring no.	Instrument no.	Instrument type	Reference no.	Coordinates	Water depth (m)	Instr. depth (m)	Sample interval (min)	Anchor deployment (1979) Day-Mo.-Hr. (GMT)	Anchor release (1979) Day-Mo.-Hr. (GMT)	Initial cycle (GMT) (1979)	Final cycle (GMT) (1979)
A TOP	3425	AA	655	Lat 33°28.2' Long 76°52.1'	200	100	20	06 AUG 1732	18 NOV 1345	31 JUL 1740	18 NOV 1419
A BOT	3343	AA	41			180	20			31 JUL 1740	18 NOV 1419
B TOP	3426	AA	622	Lat 33°21.9' Long 76°41.3'	410	270	20	03 AUG 0647	18 NOV 1150	31 JUL 1740	18 NOV 1242
B BOT	3423	AA	266			390	20			01 AUG 1620	18 NOV 1238
C TOP	3332	AA	500	Lat 33°51.1' Long 76°14.7'	400	260	20	03 AUG 1036	18 NOV 1657	31 JUL 1740	18 NOV 1811
C MID	3427	AA	733			320	20			31 JUL 1740	18 NOV 1800
C BOT	3344	AA	624			380	20			31 JUL 1740	18 NOV 1758
D TOP	3337	AA	67	Lat 33°55.1 Long 76°11.1	390	250	20	03 AUG 1556	17 NOV 2130	31 JUL 1710	17 NOV 2315
D MID*	3345	AA	30			310	20			31 JUL 1740	*
D BOT*	3424	AA	840			370	20			31 JUL 1740	*

* Failed; no data.

1.3 SUPPORTING OBSERVATIONS

Hydrographic and other observations collected during the summer array launch and recovery operations were reported by Bane *et al.* (1980). The at-sea operations were conducted in R/V *Endeavor*.

SECTION 2

Data Sources, Processing, and Basic Statistics

2.1 TRANSCRIPTION OF AANDERAA DATA TAPES

The raw data on Aanderaa magnetic tapes consist of a sequence of pulse width modulated (PCM) binary numbers. Two binary words are recorded for each sensor sampled, plus two words for an internal reference number. The binary PCM data tapes were read by a reel-to-reel tape deck, then transcribed to computer-compatible binary words by a hardware interface device built by Mr. Lawrence Ives of North Carolina State University. The decoded raw data consist of time series of numbers in the range of 0 to 1023 (decimal equivalent).

2.2 INSTRUMENT CALIBRATION

The ten Aanderaa RCM-4 recording current meters used in the Gulf Stream Meanders Experiment were calibrated for direction and temperature. The four meters which were positioned at the top of the moorings contained pressure sensors, which were also calibrated. The calibration values supplied by the manufacturer for speed and conductivity were used; no other laboratory calibration was performed for these variables. In this section the calibration procedures and results are presented, along with the manufacturer's calibration information. The calibration data, either measured or supplied by Aanderaa, were used to convert from the internally recorded binary number, N, which ranges in decimal equivalent from 0 to 1023, into scientific units. With the exception of direction, the winter experiment calibration coefficients

were also used for the summer experiment. Only the new direction calibration curves are shown in this report; for other calibration curves, see TAMU technical report number 80-7-T.

Speed

The conversion from N to speed, in cm/sec, was accomplished with the linear formula

$$\text{Speed} = 1.5 + 0.14\ N.$$

The values 1.5 and 0.14 were supplied by Aanderaa.

Conductivity

Aanderaa calibration values for conductivity were used for all meters. The coefficients in the linear formula

$$\text{Conductivity (mmho/cm)} = A + BN$$

are listed in Table 2.

Direction

Each RCM-4 compass was calibrated as follows: The instrument was mounted on a non-magnetic bracket located away from known magnetic interference. With the internal digitizing and recording mechanisms set to continuously record, the instrument was turned through 360°, indexing by ten degrees, allowing the compass to stablize at each position and to record at least six cycles of the direction reading. A cubic equation of the form

$$\text{Direction (magnetic)} = A + BN + CN^2 + DN^3$$

was fitted to the 36 calibration values. The coefficients A through D for each meter are listed in Table 2. The direction values from the cubic equation differed by less than one degree from the measured calibration values. Graphs of the calibration curve and the Aanderaa curve for the eight meters which operated successfully are shown in Fig. 5.

Temperature

All temperature sensors were calibrated as follows: With all meters sealed and recording at 15 minute intervals, they were immersed in an icewater bath. The ice was allowed to slowly melt, and the water to warm to room temperature (~25°C). Stirring was provided throughout the warming period by two small pumps. Four independent Hewlett-Packard quartz-crystal thermometers were placed around the bath for temperature measurement. A continuous record (strip chart) of the temperature measured by one of the quartz sensors was made and used as the calibration standard. Temperature readings around the bath using the other three sensors showed the temperature differences to be always less than 0.05°C,[1] insuring that all meters were recording essentially the same temperature. Calibration temperatures at known times of RCM-4 recordings were compared with the corresponding recorded values of N. A number (*ca.* 15 to 19) of Temperature-N pairs were used to determine the best fit to the cubic equation:

$$\text{Temperature (°C)} = A + BN + CN^2 + DN^3$$

The coefficients A through D are listed for each meter in Table 2, along with the coefficients supplied by Aanderaa. The difference between the temperature calibration values computed from the cubic equation and those directly measured was in all cases less than the stated accuracy of the temperature sensor (0.15 °C).

Pressure

The pressure transducers on instruments 3425, 3426, 3332 and 3337 were calibrated using a manual hydraulic pump. Calibration data were collected in the range 0 to 500 PSIG at intervals of 50 PSIG, covering the approximate depth range of 0 to 350 m. These points were fitted to the cubic equation

---

[1] After all ice had melted.

$$\text{Pressure (PSIG)} = A + BN + CN^2 + DN^3.$$

The coefficients in the cubic equation for each meter are listed in Table 2, along with the Aanderaa coefficients.

Salinity

Salinity values were calculated from the temperature and conductivity time series in scientific units as follows: The conductivity that seawater with a salinity of 35 ‰ would have at the measured temperature was calculated using the formula

$$\text{Cond (T, 35)} = 29.01067 + 0.8677579\ T + 0.4074545\times10^{-2}\ T^2 - 0.1437152\times10^{-4}\ T^3,$$

where T is the measured temperature (°C) and Cond is in mmho/cm. This formula is the best-fit cubic equation calculated from information presented by Weyl (1964). The conductivity ratio at the measured temperature was calculated by

$$R_T = \text{Cond (meas)} / \text{Cond (T, 35)},$$

where Cond (meas) is the measured conductivity in mmho/cm. The difference, Δ_{15}, between the conductivity ratio at 15°C and R_T was calculated with the formula (National Institute of Oceanography of Great Britain and Unesco, 1971)

$$\Delta_{15} = 10^{-5}\ R_T\ (R_T-1)\ (T-15)\ [96.7-72.0\ R_T + 37.3\ R_T^2 - (0.63 + 0.21\ R_T^2)\ (T-15)].$$

The salinity in parts per thousand was then calculated using the formula (*ibid.*)

$$S(‰) = -0.08996 + 28.29720\ R_{15} + 12.80832\ R_{15}^2 - 10.67869\ R_{15}^3 + 5.98624\ R_{15}^4 - 1.32311\ R_{15}^5,$$

where $R_{15} = R_T + \Delta_{15}$.

Table 2. Aanderaa-supplied (Aa) and calibration-produced (Cal) coefficients for the conversion of recorded binary numbers to scientific units. The general formula $V = A + BN + CN^2 + DN^3$ was used, where V is the variable, and N is decimal equivalent (0 - 1023) of the recorded binary number.

Variable / Meter No.		Speed (cm sec^{-1})		Direction (degrees mag)		Conductivity (mmho cm^{-1})		Temperature (°C)		Pressure (kg cm^{-2})	(PSI)
		Aa	Cal	Aa	Cal	Aa	Cal	Aa	Cal	Aa	Cal
3332	A	1.5		1.5	-5.1395	0		-0.885	-0.4144	-4.30567	-53.4979
	B	0.14		0.349	0.3218	0.07593		0.03587	0.0361	0.0770611	1.1150
	C				0.7794×10^{-4}			-0.8388×10^{-5}	-0.8734×10^{-5}		-0.2201×10^{-3}
	D				-0.5684×10^{-7}			0.4300×10^{-8}	0.4470×10^{-8}		0.3127×10^{-6}
3337	A	1.5		1.5	-5.0853	0.076		-0.0905	-0.3128	-3.78849	-67.9111
	B	0.14		0.349	0.3478	0.07607		0.03587	0.0375	0.0758634	1.3185
	C				0.8150×10^{-5}			-0.8388×10^{-5}	-0.1230×10^{-5}		-0.8994×10^{-3}
	D				-0.9962×10^{-8}			0.4300×10^{-8}	0.6655×10^{-8}		0.9220×10^{-6}
3343	A	1.5		1.5	-8.5998	-0.084		-0.9103	-0.3176		
	B	0.14		0.349	0.3519	0.07593		0.03587	0.0375		
	C				0.2027×10^{-4}			-0.8388×10^{-5}	-0.1260×10^{-5}		
	D				-0.2458×10^{-7}			0.4300×10^{-8}	0.6858×10^{-8}		
3344	A	1.5		1.5	-7.4634	-0.084		-0.0905	-0.2421		
	B	0.14		0.349	0.3561	0.07593		0.03587	0.0372		
	C				0.1300×10^{-4}			-0.8388×10^{-5}	-0.1226×10^{-5}		
	D				-0.2292×10^{-7}			0.4300×10^{-8}	0.7004×10^{-8}		
3345	A	1.5		1.5		0.076		-0.0773	-0.2877		
	B	0.14		0.349	No calibration data	0.07597		0.03587	0.0367		
	C							-0.8388×10^{-5}	-0.1044×10^{-5}		
	D							0.4300×10^{-8}	0.5516×10^{-8}		
3423	A	1.5		1.5	-9.7707	0		-0.9511			
	B	0.14		0.349	0.3946	0.07574		0.03587	No calibration data		
	C				-0.7497×10^{-4}			-0.8388×10^{-5}			
	D				0.2784×10^{-7}			0.4300×10^{-8}			
3424	A	1.5		1.5		0		-0.0781	-0.079		
	B	0.14		0.349	No calibration data	0.07650		0.03587	0.0386		
	C							-0.8388×10^{-5}	-0.1790×10^{-5}		
	D							0.4300×10^{-8}	1.1579×10^{-8}		
3425	A	1.5		1.5	-4.2754	0.07574		-0.8651	-0.2713	-3.92634	-65.2533
	B	0.14		0.349	0.3842	0.07574		0.03587	0.0377	0.0757081	1.2346
	C				-0.9950×10^{-4}			-0.8388×10^{-5}	-1.3034×10^{-5}		-0.5164×10^{-3}
	D				0.6525×10^{-7}			0.4300×10^{-8}	0.7184×10^{-8}		0.5034×10^{-6}
3426	A	1.5		1.5	-0.8219	0		-0.8827	-0.2922	-4.20412	-72.1725
	B	0.14		0.349	0.3886	0.07598		0.03587	0.0375	0.0761238	1.3555
	C				-0.8587×10^{-4}			-0.8388×10^{-5}	-1.2131×10^{-5}		-1.0077×10^{-3}
	D				0.4428×10^{-7}			0.4300×10^{-8}	0.6462×10^{-8}		1.0679×10^{-6}
3427	A	1.5		1.5	-6.2256	0.07612		-0.9121	-0.3606		
	B	0.14		0.349	0.3736	0.07612		0.03587	0.0380		
	C				-0.7050×10^{-4}			-0.8388×10^{-5}	-1.3525×10^{-5}		
	D				0.4491×10^{-7}			0.4300×10^{-8}	0.7438×10^{-8}		

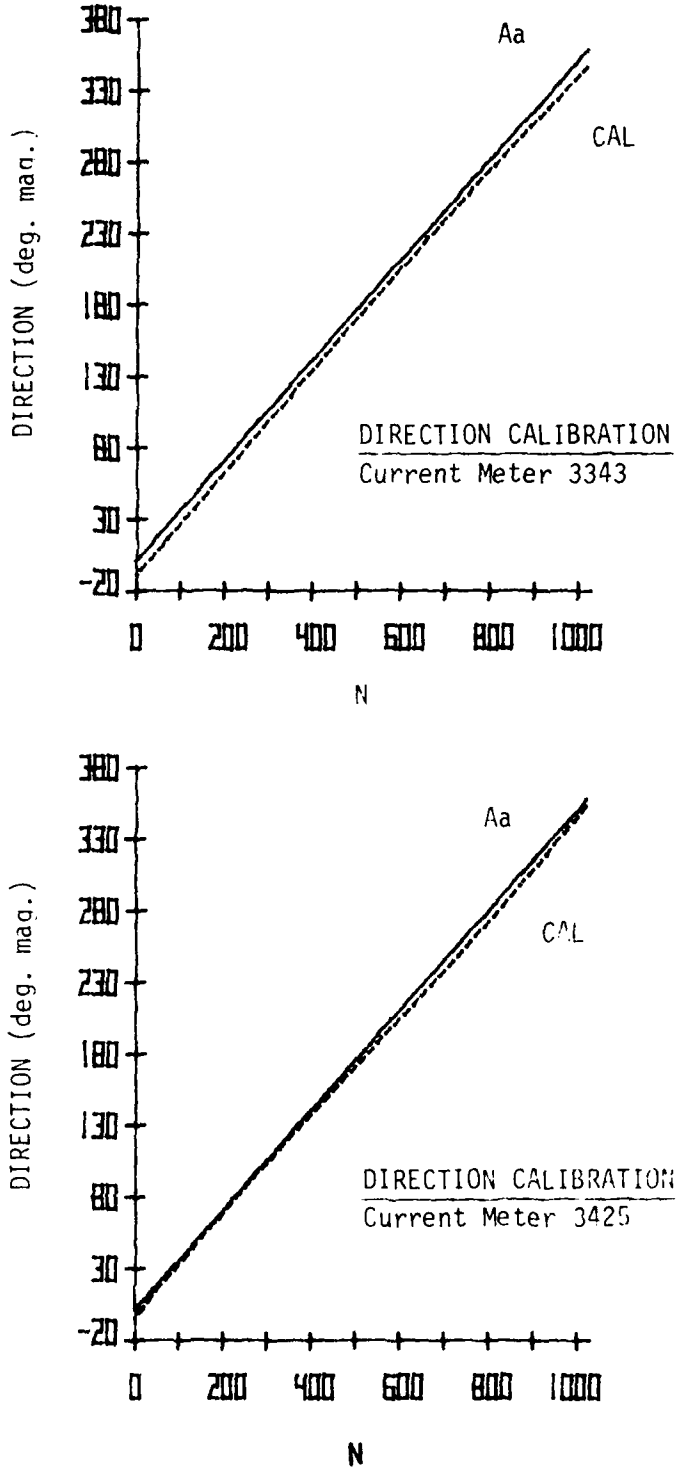
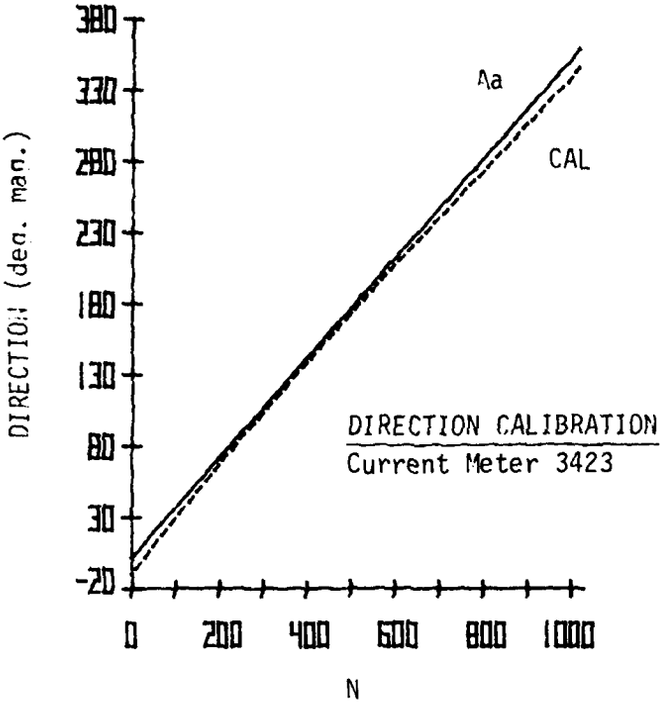


Figure 5. Calibration curves for compass direction, based on coefficients supplied by Aanderaa (-) and coefficients based on directly measured calibration data (----). The latter were used for calibration of all instruments.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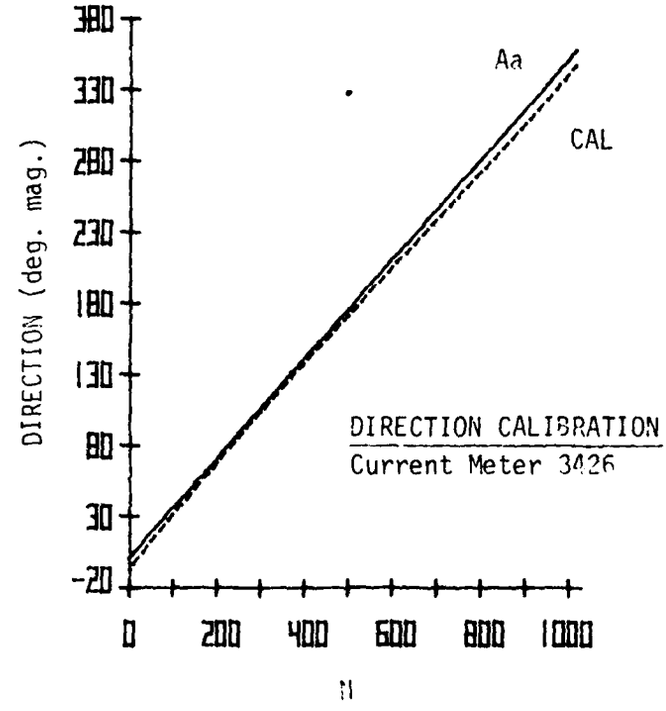
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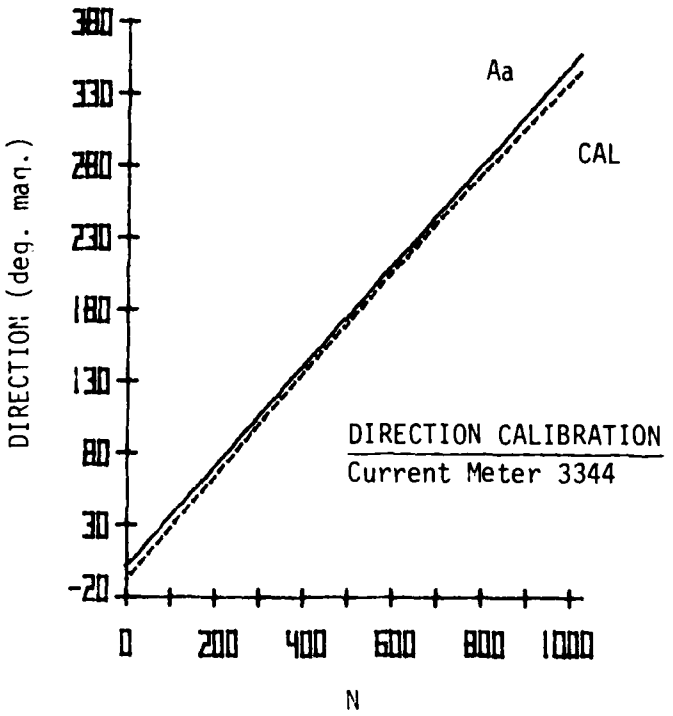
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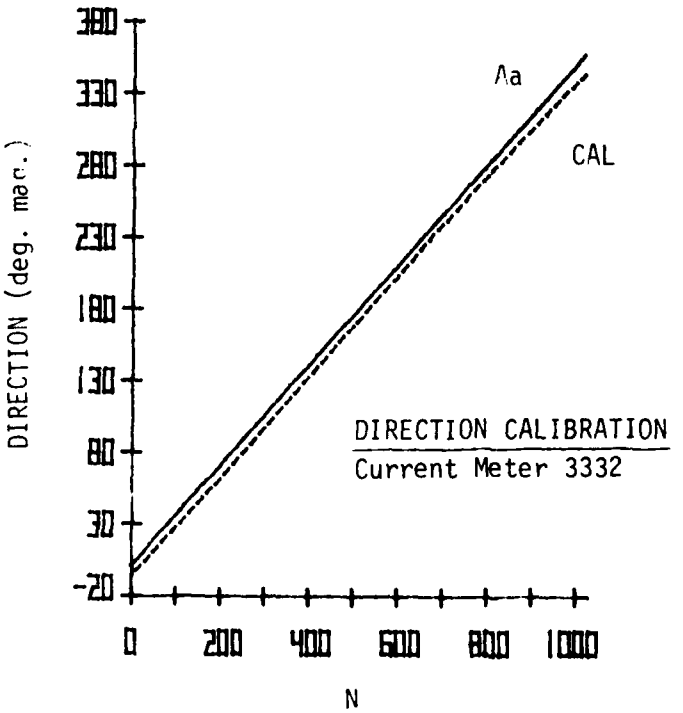
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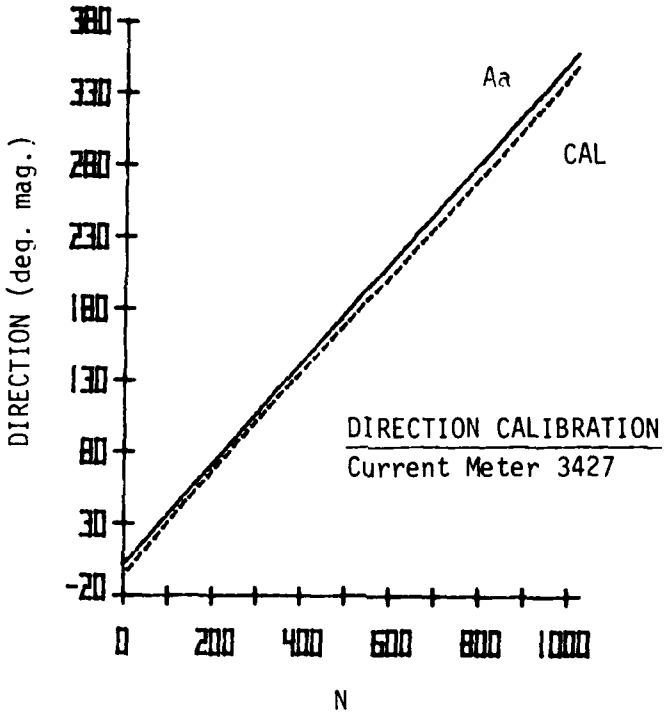
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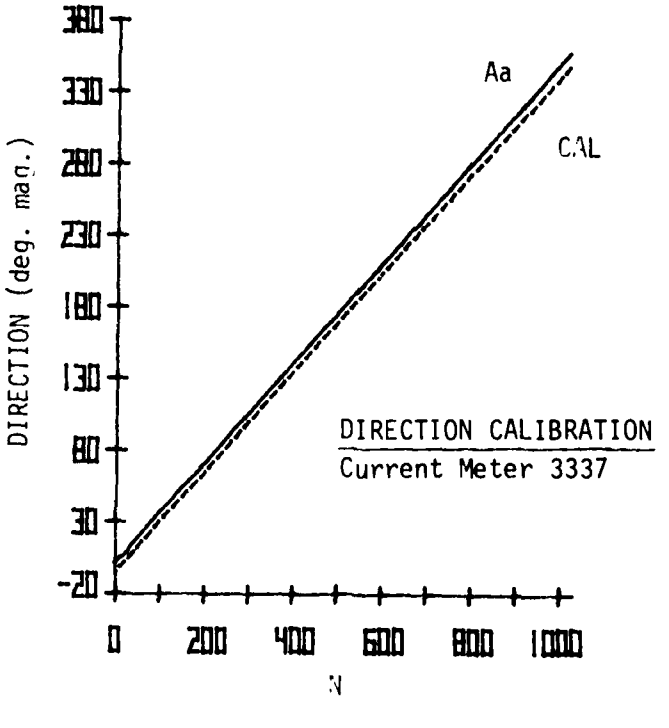
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DIRECTION CALIBRATION
Current Meter 3337

2.3 AANDERAA DATA EDITING

The calibrated Aanderaa data files were machine-edited for extreme values exceeding reasonable upper and lower bounds on each variable. Bad points were replaced by values linearly interpolated between the preceding and succeeding good points. The data were then plotted, and further editing of unreasonable values was done by operating on the data files interactively using a computer terminal. All edited points were replaced by interpolated values, as in the machine-edited case.

2.4 ANCILLARY DATA SOURCES

Atmospheric surface observations at Cape Hatteras and at NDBO moored buoys number 41004 and 41002, Fig. 1, were obtained from the National Archives for the summer array period. The Hatteras atmospheric data shown here are air temperature and atmospheric pressure. In addition, the wind stress vector components were computed, using a constant drag coefficient $C_D = 1.5 \times 10^{-3}$. The shallow NDBO buoy (NDBO-4 on Fig. 1) was located at 32.6°N, 78.7°W, approximately on the 100 m isobath, and the offshore buoy (NDBO-2 on Fig. 1) was located at 32.3°N, 75.3°W, approximately on the 3800 m isobath. The NDBO data presented are air and sea surface (water) temperatures and atmospheric pressure. The NDBO wind stress components are also shown.

2.5 DATA PROCESSING

The raw, calibrated data from the current meters consisted of time series of current speed and direction, temperature, salinity, and (only for top instruments) pressure. The basic sampling interval for all current meters was 20 minutes. Current speed and direction were converted to (u, v) vector velocity components in an (offshore, downstream) coordinate frame rotated

clockwise 34 degrees from true north to align with the 400 m isobath. The same coordinate frame was used for all vector data sets, which facilitates direct comparison between them.

Standard digital filtering techniques based on the FESTSA time series analysis system (Brooks, 1976) were used to subdivide the frequency domain of the data sets. First, a 3-hour low pass filter (3 HRLP) was applied to reduce sampling noise and possible aliasing. Then a 40-hour low pass filter (40 HRLP) was applied to separate the daily and semidaily tidal and inertial motions from those with periods of several days and longer. For both filters, the specified cutoff period is the period at which the filter energy response is 0.25 times its long period response (-6db point). A Lanczos taper was used in each case, and the smoothed response function of the 40 HRLP filter is shown in Fig. 6. The response at the semidaily (dominant) tidal period is less than 10^{-7}. In addition, a 3 to 40 hours bandpass (3-40 HRBP) data set was obtained by subtracting the 40 HRLP set from the 3 HRLP set. The final sample interval was 1 hour for the 3 HRLP and 3-40 HRBP sets and 6 hours for the 40 HRLP set.

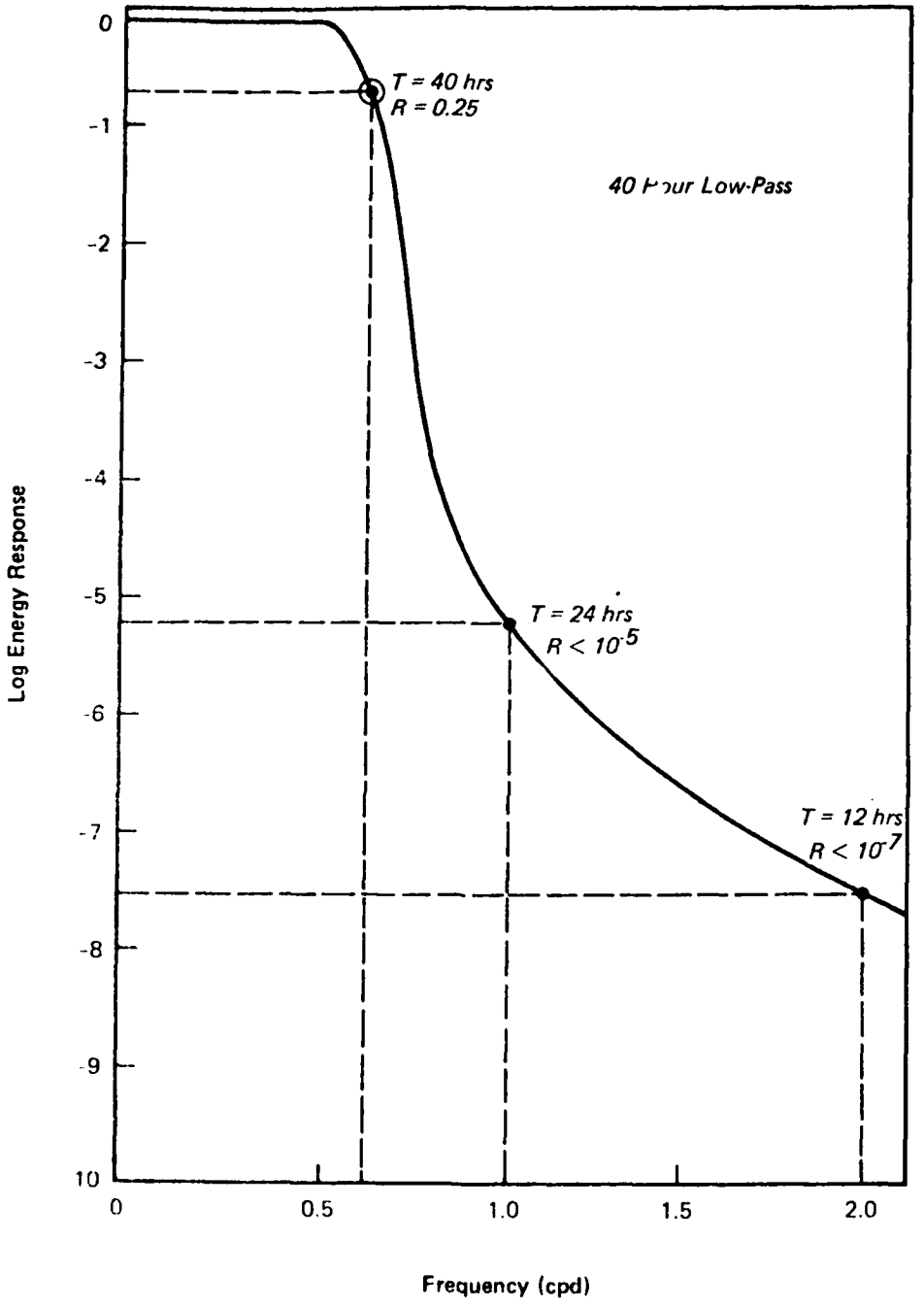


Figure 6. Response function for the 40 hour low pass Lanczos filter.

2.6 BASIC STATISTICS OF THE CURRENT METER DATA SET

First order and variance statistics for u, v, and T (temperature) from each current meter are shown in Table 3. No data are presented for instruments number 3345 and 3424, which failed. These instruments were located at the D MID and D BOT positions, respectively. Table 4 shows the variance ratios 3-40 HRBP/3 HRLP and 40 HRLP/3 HRLP, which approximately represent the division of total spectrum energy between the tidal-inertial band and the long period band, respectively. Departure of their sum from unity for each variable is a measure of filtering imperfection. The tidal-inertial band motions were strongest in the cross-shelf (u) component, particularly at the deepest instruments. The downstream (v) component fluctuations predominantly had periods of several days and longer.

Table 3. First-order and variance statistics of temperature (T) and velocity components (u, v) from each instrument, shown from 3 HRLP, 3-40 HRLP, and 40 HRLP filtered data sets.

3 HRLP

Current meter	Parameter	N	Min	Max	Mean	SD	Var
A TOP	T	2472	12.1	24.3	17.7	2.3	5.2
	S	2472	35.2	36.6	36.0	0.3	0.1
	U	1210	-37.4	50.2	2.1	12.5	155.8
	V	1210	-86.1	126.1	5.4	44.2	1951.9
A BOT	T						
	S						
	U	2472	-50.8	31.3	-7.8	10.2	103.4
	V	2472	-65.6	75.5	1.5	19.6	384.2
B TOP	T	2470	8.5	17.4	11.9	2.3	5.1
	S	2470	34.8	36.2	35.3	0.3	0.1
	U	2470	-59.2	48.3	-0.7	16.4	270.6
	V	2470	-40.7	126.1	25.8	30.4	921.7
B BOT	T	2470	5.7	12.2	8.2	1.2	1.5
	S	2470	35.6	36.2	35.8	0.1	0.0
	U	2471	-35.8	41.4	1.1	10.0	100.0
	V	2471	-41.1	66.7	6.4	19.1	363.3
C TOP	T	2475	8.7	17.2	12.0	1.9	3.6
	S	2475	35.1	36.4	35.5	0.3	0.1
	U	2475	-37.9	35.8	-1.4	10.1	101.6
	V	2475	-57.4	139.0	25.1	34.4	1182.7
C MID	T	2475	7.7	16.0	10.5	1.5	2.3
	S	2475	34.7	35.9	35.0	0.2	0.0
	U	2401	-30.3	36.5	0.2	8.5	72.9
	V	2401	-56.2	113.1	16.6	26.9	725.2
C BOT	T	2054	6.1	13.4	8.8	1.1	1.2
	S	2054	34.7	35.5	34.9	0.1	0.0
	U	2054	-24.4	29.4	-0.7	7.6	57.3
	V	2054	-49.5	63.1	7.6	19.2	370.6
D TOP	T	2456	8.9	17.1	12.3	1.8	3.2
	S	2456	34.9	36.2	35.4	0.3	0.1
	U	2456	-40.9	38.9	0.7	9.7	93.7
	V	2456	-47.7	141.6	23.9	34.0	1154.0

Current meter	Parameter	N	Min	Max	Mean	SD	Var
A TOP	T	2280	-2.1	1.8	0.0	0.5	0.2
	S	2280	-0.3	0.4	0.0	0.1	0.0
	U	1018	-34.2	25.3	0.0	7.3	52.7
	V	1018	-29.8	23.7	0.0	7.1	50.3
A BOT	T						
	S						
	U	2280	-23.4	27.5	0.0	6.1	37.3
	V	2280	-29.7	32.6	0.0	6.3	39.2
B TOP	T	2278	-1.3	1.3	0.0	0.4	0.1
	S	2278	-0.2	0.2	0.0	0.1	0.0
	U	2278	-21.3	21.3	0.0	6.2	38.1
	V	2278	-31.2	30.2	0.0	7.3	53.4
B BOT	T	2278	-1.8	1.9	0.0	0.3	0.1
	S	2278	-0.2	0.2	0.0	0.0	0.0
	U	2279	-21.6	24.8	0.0	5.7	32.5
	V	2279	-21.4	17.6	0.0	5.1	26.3
C TOP	T	2283	-1.9	1.6	0.0	0.4	0.2
	S	2283	-0.3	0.3	0.0	0.1	0.0
	U	2283	-22.5	22.4	0.0	5.6	31.0
	V	2283	-32.4	40.1	0.0	7.7	58.8
C MID	T	2283	-1.8	1.7	0.0	0.4	0.1
	S	2283	-0.3	0.3	0.0	0.1	0.0
	U	2209	-27.5	18.8	0.0	5.7	32.1
	V	2209	-23.3	33.4	0.0	6.3	39.3
C BOT	T	1862	-1.4	1.8	0.0	0.3	0.1
	S	1862	-0.3	0.3	0.0	0.0	0.0
	U	1862	-23.3	21.8	0.0	5.9	34.8
	V	1862	-17.3	19.7	0.0	5.2	27.0
D TOP	T	2264	-1.7	1.8	0.0	0.4	0.2
	S	2264	-0.3	0.3	0.0	0.1	0.0
	U	2264	-33.5	19.9	0.0	5.3	28.0
	V	2264	-36.7	43.2	0.0	8.0	64.2

Current meter	Parameter	N	Min	Max	Mean	SD	Var
A TOP	T	380	12.6	23.1	17.6	2.2	5.0
	S	380	35.2	36.4	36.0	0.3	0.1
	U	170	-21.0	34.3	2.3	9.9	98.6
	V	170	-75.1	115.9	4.8	45.0	2026.8
A BOT	T						
	S						
	U	380	-45.7	25.2	-7.9	8.3	68.7
	V	380	-55.4	61.2	1.1	18.4	336.7
B TOP	T	380	8.5	17.2	11.9	2.3	5.1
	S	380	34.8	36.2	35.3	0.3	0.1
	U	380	-49.2	33.9	-0.5	14.8	218.2
	V	380	-28.8	120.7	26.5	29.3	856.7
B BOT	T	380	5.9	11.8	8.2	1.2	1.4
	S	380	35.6	36.2	35.8	0.1	0.0
	U	380	-24.2	19.3	1.1	7.8	61.0
	V	380	-31.7	57.9	6.8	18.2	330.1
C TOP	T	381	8.7	17.0	12.0	1.9	3.5
	S	381	35.1	36.3	35.5	0.3	0.1
	U	381	-27.1	20.2	-1.6	8.1	65.9
	V	381	-53.0	124.1	25.2	33.1	1093.0
C MID	T	381	8.0	15.1	10.5	1.4	2.1
	S	381	34.7	35.8	35.0	0.2	0.0
	U	369	-15.8	19.9	0.1	6.1	37.2
	V	369	-49.9	87.4	16.5	26.1	682.3
C BOT	T	311	6.3	12.5	8.8	1.0	1.0
	S	311	34.8	35.4	34.9	0.1	0.0
	U	311	-17.2	12.9	-0.7	4.6	21.3
	V	311	-42.7	51.0	7.6	18.9	356.8
D TOP	T	378	9.0	17.3	12.3	1.8	3.1
	S	378	34.9	36.2	35.4	0.3	0.1
	U	378	-24.2	32.5	0.6	8.1	65.3
	V	378	-45.1	118.1	24.7	33.0	1087.0

Table 4. Sub-band variance ratios for temperature (T) and velocity components (u, v) from each instrument. The sub-bands approximately divide the principal tidal and inertial spectrum (3-40 HRBP) for the low frequency spectrum (40 HRLP).

Current meter	Parameter	Variance ratio 3-40 HR BP / 3 HRLP	Variance ratio 40 HRLP / 3 HRLP
A TOP	T	0.04	0.96
	U	0.34	0.63
	V	0.03	1.04
A BOT	T	---	---
	U	0.36	0.66
	V	0.10	0.88
B TOP	T	0.02	1.00
	U	0.14	0.81
	V	0.06	0.93
B BOT	T	0.67	0.93
	U	0.33	0.61
	V	0.07	0.91
C TOP	T	0.06	0.97
	U	0.31	0.65
	V	0.05	0.92
C MID	T	0.04	0.91
	U	0.44	0.51
	V	0.05	0.94
C BOT	T	0.08	0.83
	U	0.61	0.37
	V	0.07	0.96
D TOP	T	0.06	0.97
	U	0.30	0.70
	V	0.06	0.94

The 3 HRLP mean velocity vectors are shown on the mooring array plan view. (Fig. 3). The largest mean departure from the downstream direction occurred for the A-bottom instrument, possibly indicating bottom boundary layer effects.

Polar histograms giving the distribution of the normalized, cumulative 3 HRLP vector magnitude are shown in Figs. 7 through 14. The coordinate rotation angle is shown in Figs. 7 through 14 by the radial tick mark at 34° clockwise from north.

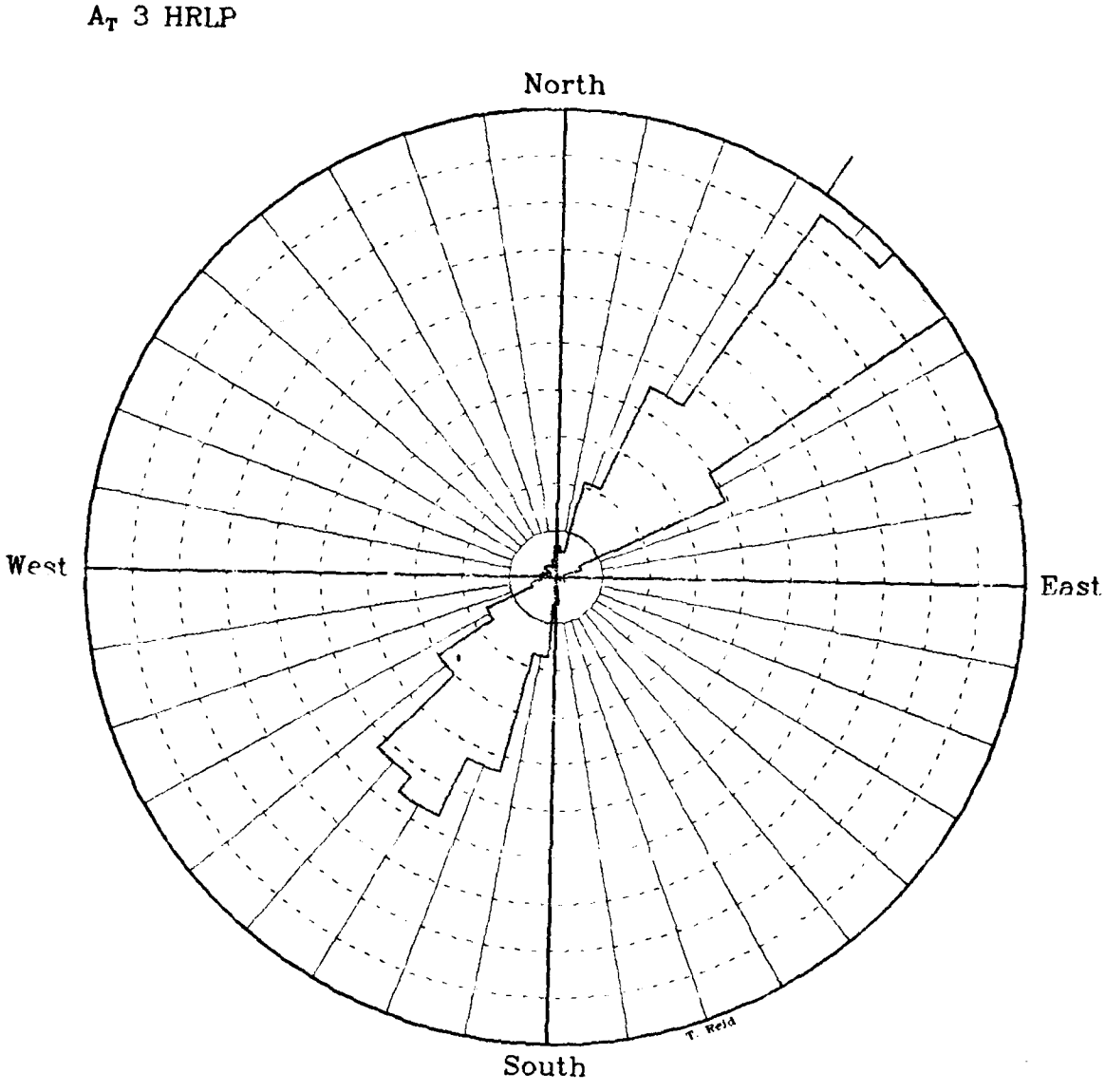


Figure 7. Polar histogram for instrument A-top showing the normalized magnitude distribution of the 3 HRLP velocity, accumulated vectorially in ten degree sectors. The downstream (+ v) direction of the rotated coordinate system is shown by the radial tick mark.

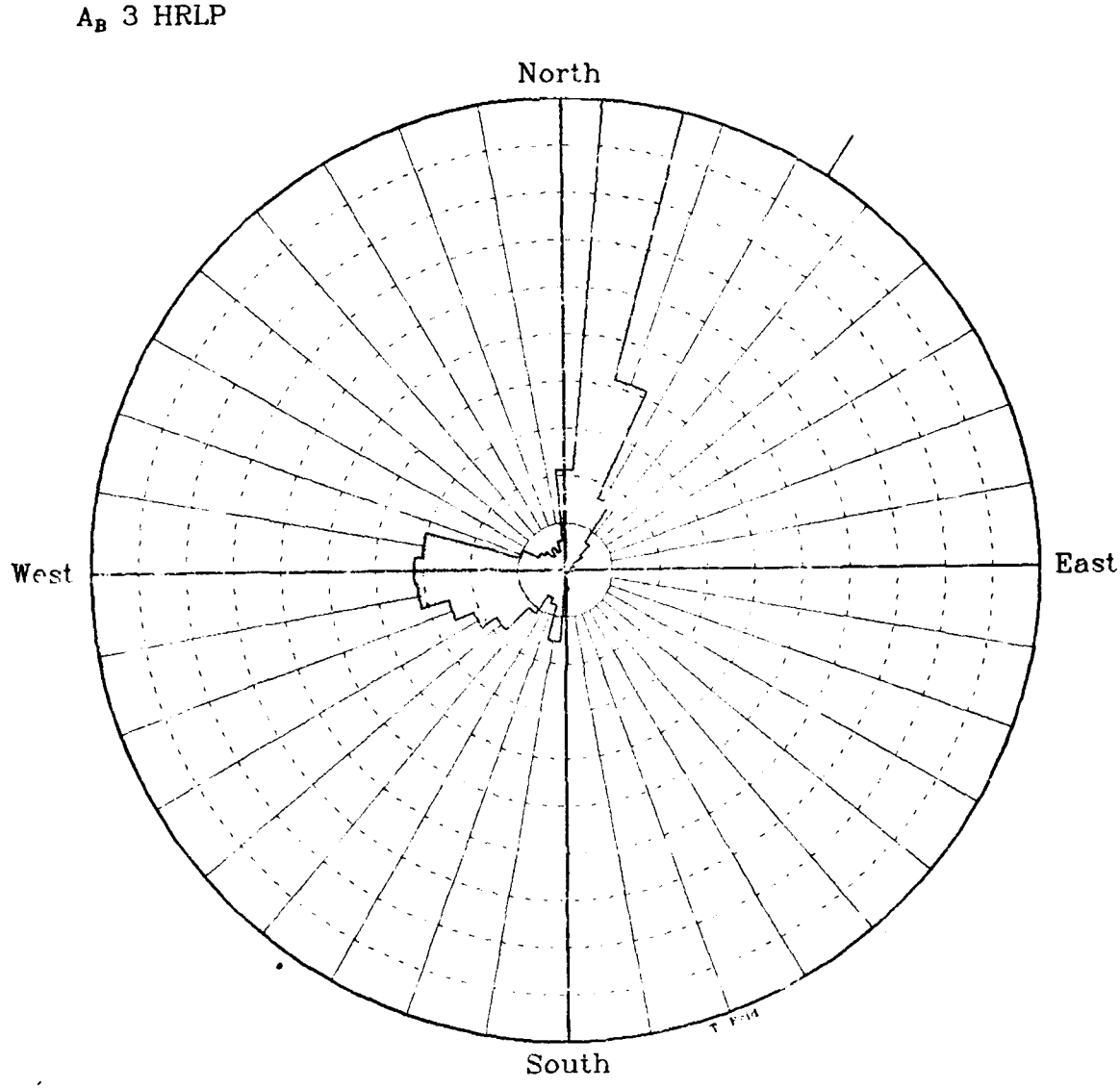


Figure 8. Polar histogram for instrument A-bot showing the normalized magnitude distribution of the 3 HRLP velocity, accumulated vectorially in ten degree sectors. The downstream (+ v) direction of the rotated coordinate system is shown by the radial tick mark.

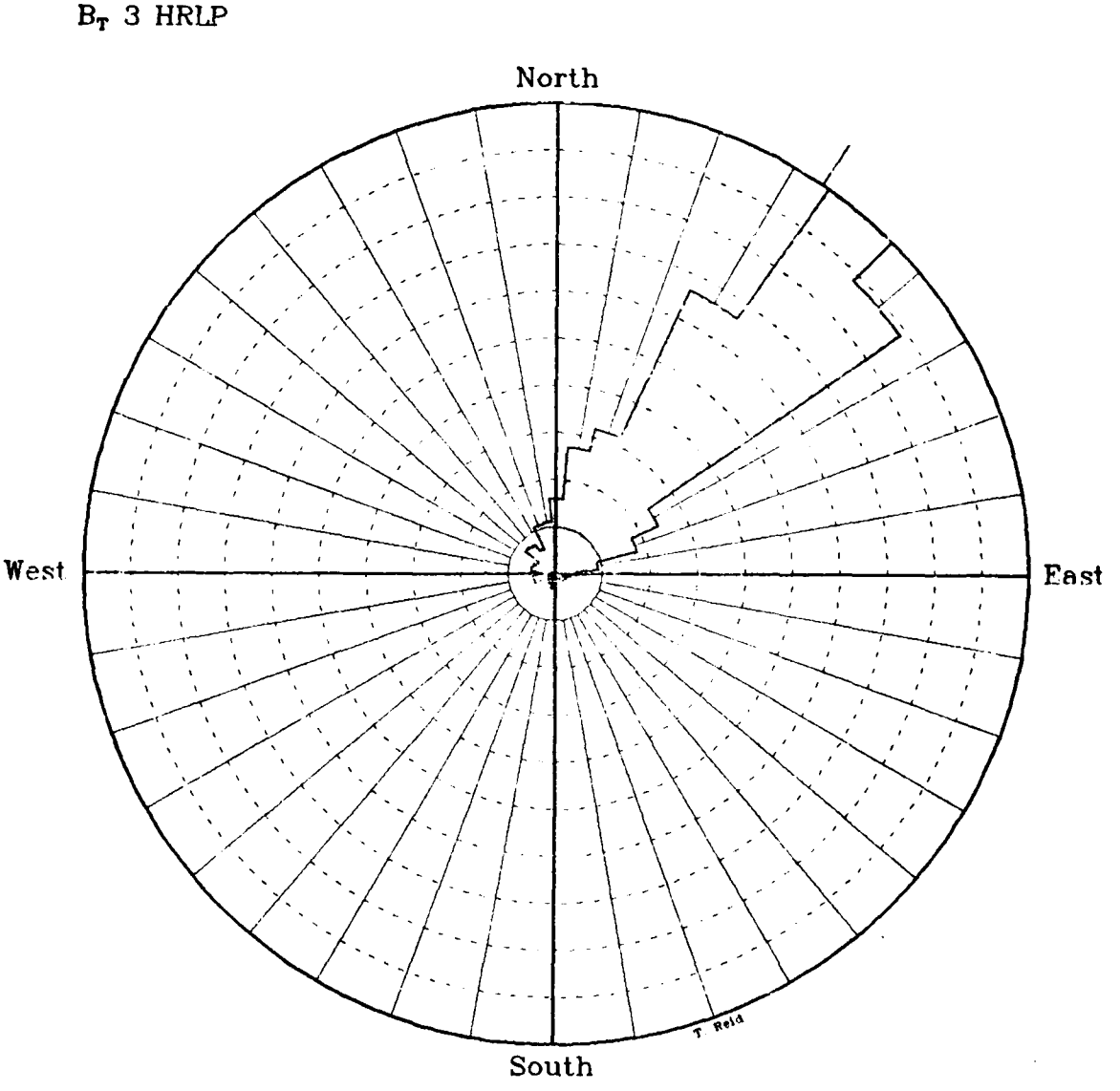


Figure 9. Polar histogram for instrument B-top showing the normalized magnitude distribution of the 3 HRLP velocity, accumulated vectorially in ten degree sectors. The downstream (+ v) direction of the rotated coordinate system is shown by the radial tick mark.

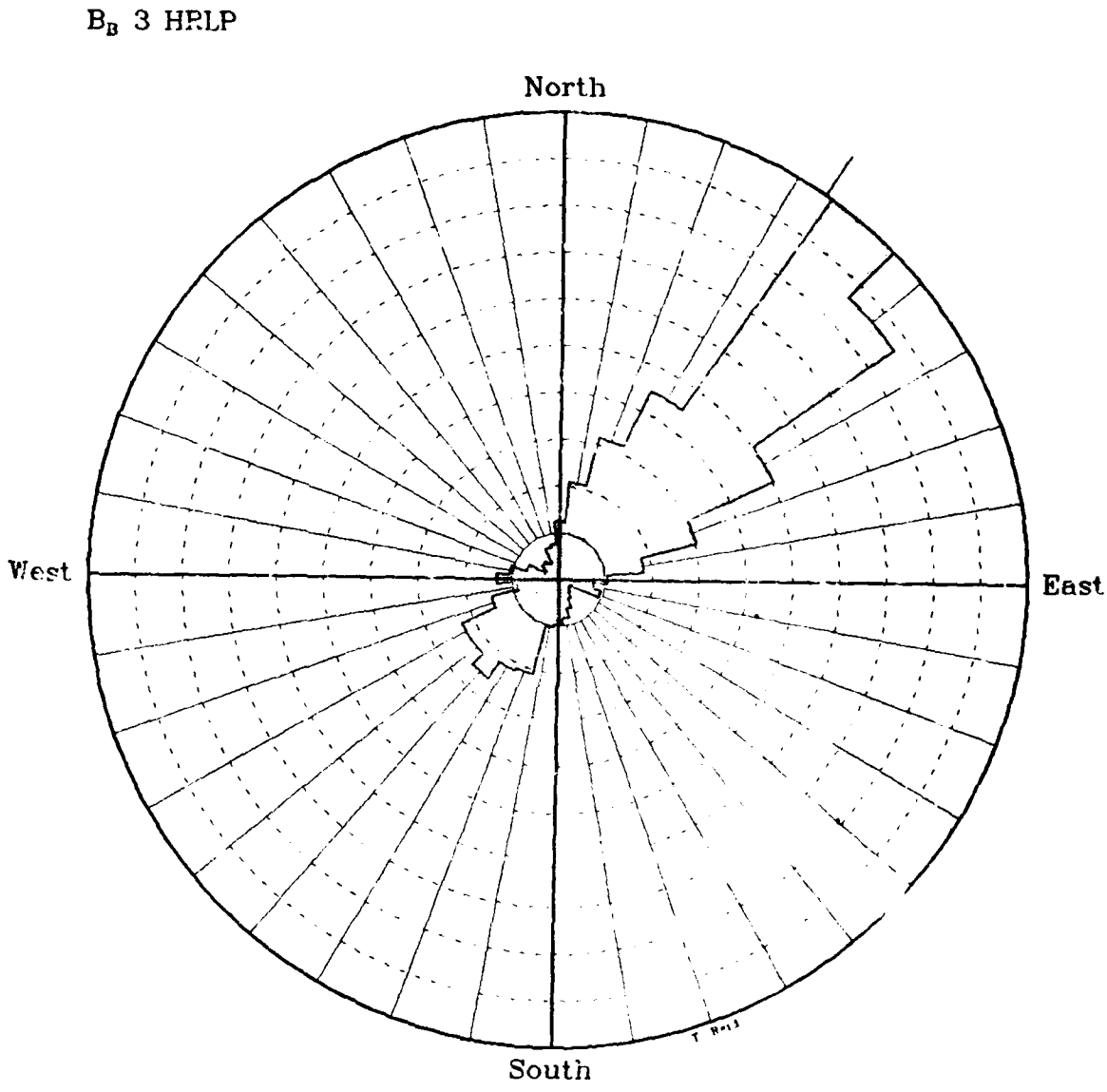


Figure 10. Polar histogram for instrument B-bot showing the normalized magnitude distribution of the 3 HRLP velocity, accumulated vectorially in ten degree sectors. The downstream (+ v) direction of the rotated coordinate system is shown by the radial tick mark.

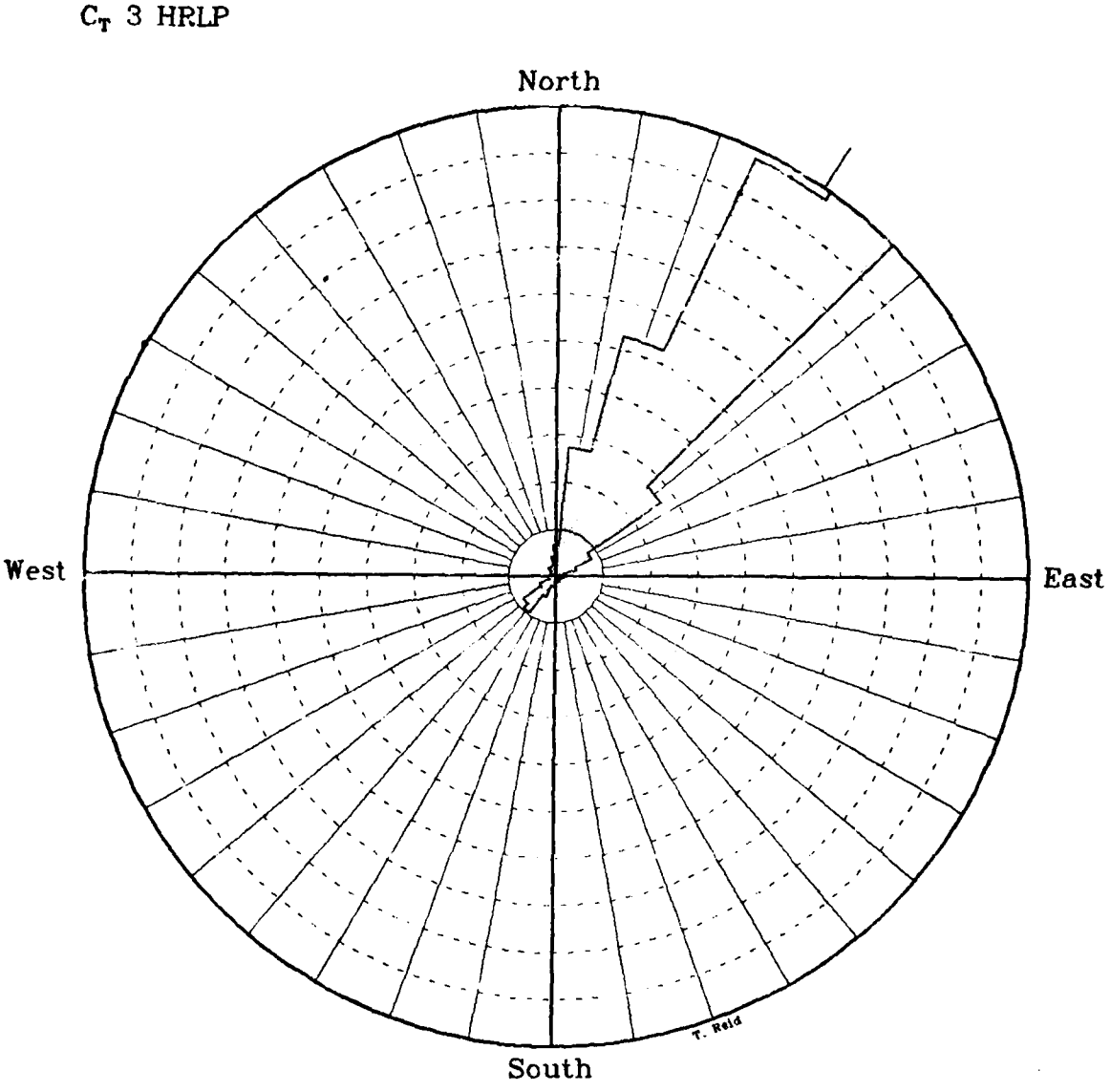


Figure 11. Polar histogram for instrument C-top showing the normalized magnitude distribution of the 3 HRLP velocity, accumulated vectorially in ten degree sectors. The downstream (+ v) direction of the rotated coordinate system is shown by the radial tick mark.

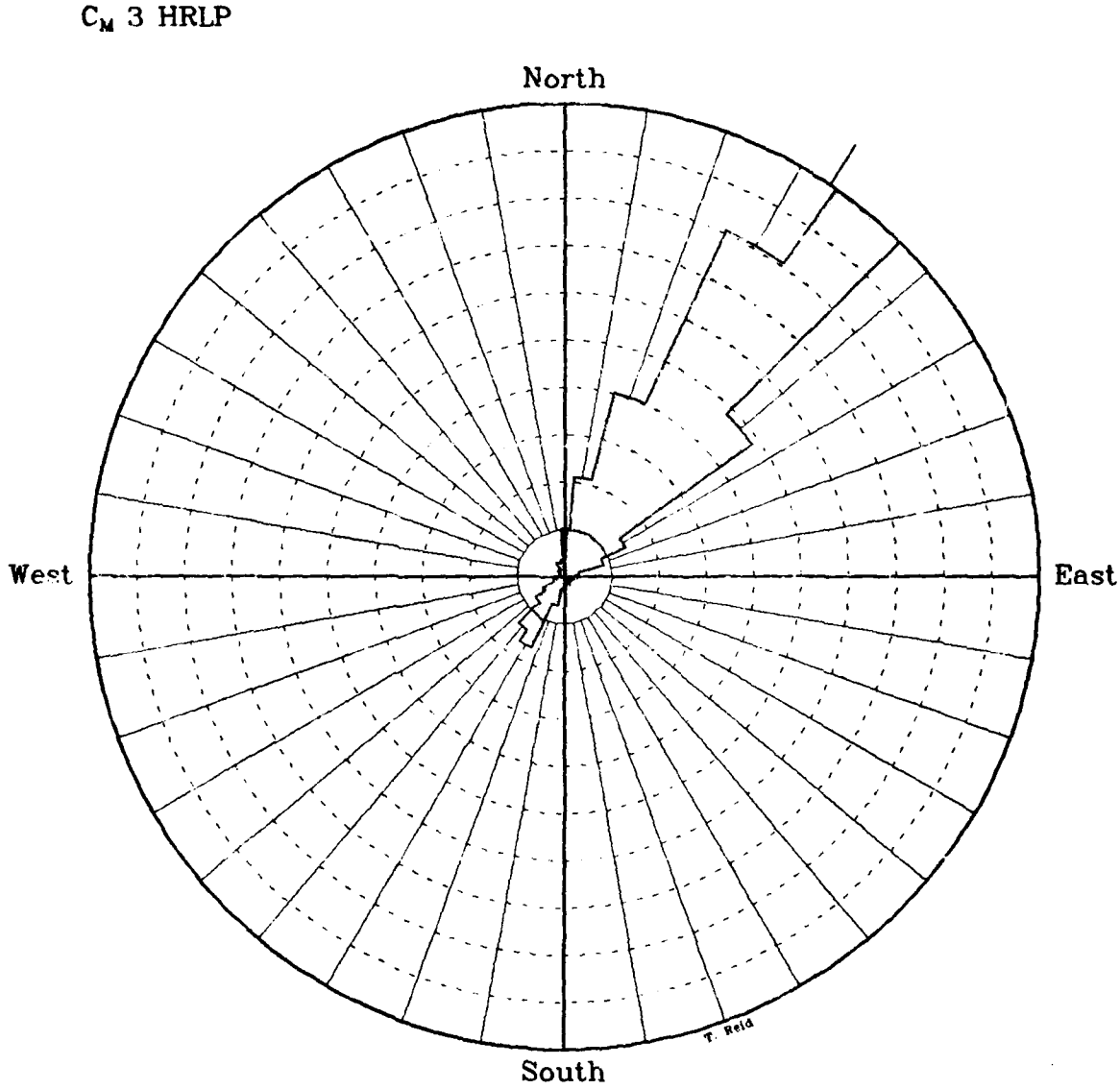


Figure 12. Polar histogram for instrument C-mid showing the normalized magnitude distribution of the 3 HRLP velocity, accumulated vectorially in ten degree sectors. The downstream (+ v) direction of the rotated coordinate system is shown by the radial tick mark.

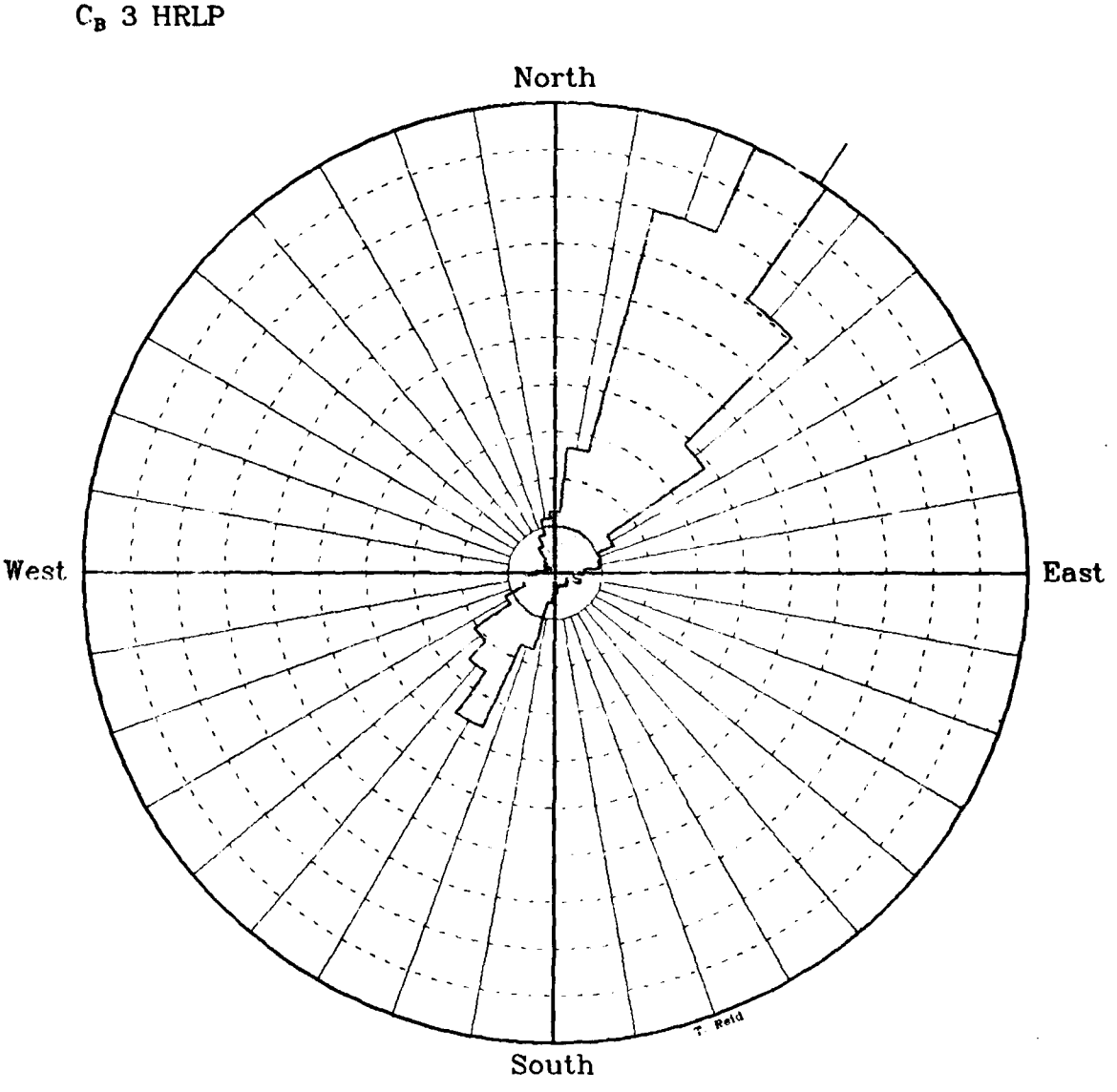


Figure 13. Polar histogram for instrument C-bot showing the normalized magnitude distribution of the 3 HRLP velocity, accumulated vectorially in ten degree sectors. The downstream (+ v) direction of the rotated coordinate system is shown by the radial tick mark.

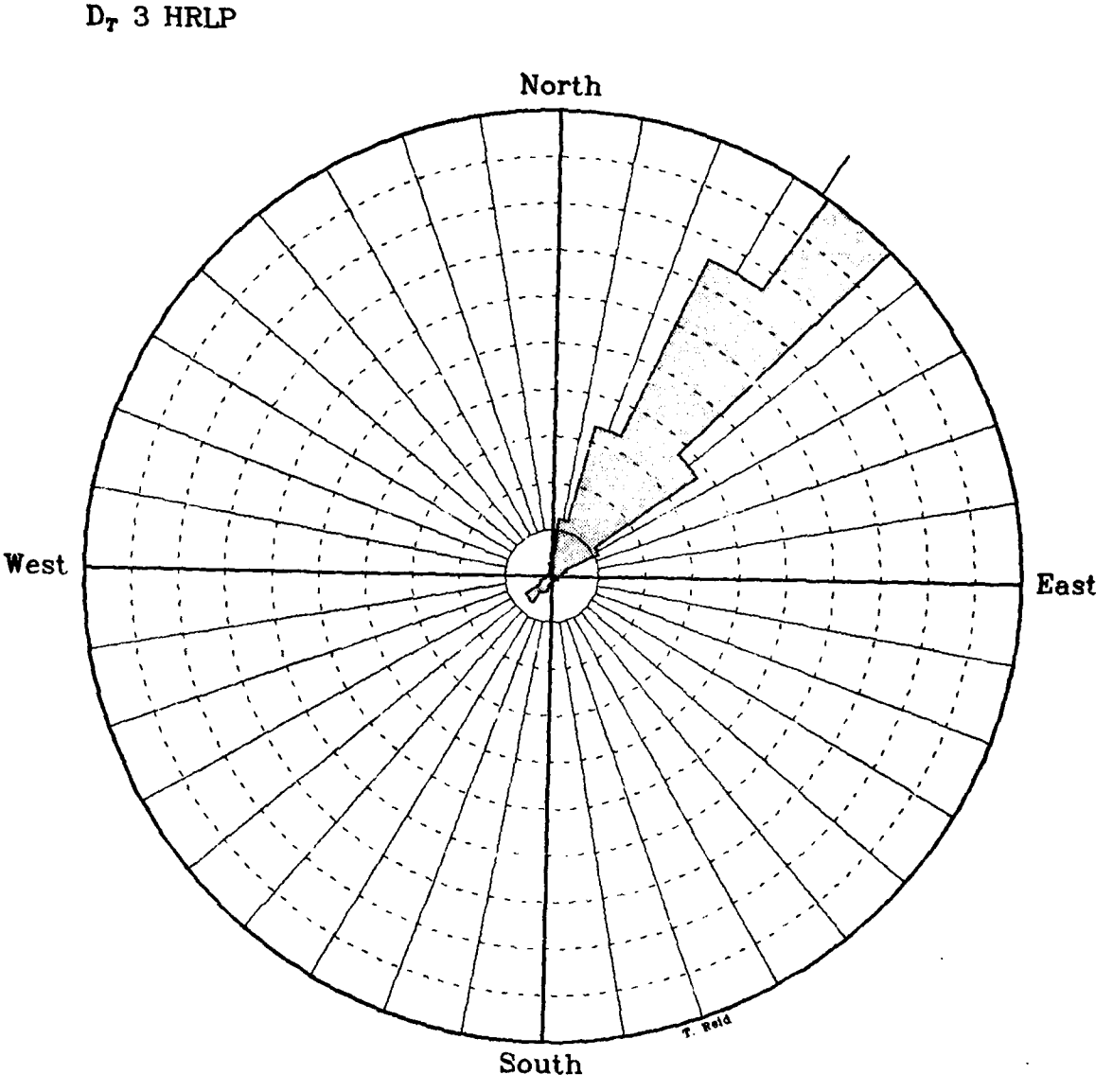


Figure 14. Polar histogram for instrument D-top showing the normalized magnitude distribution of the 3 HRLP velocity, accumulated vectorially in ten degree sectors. The downstream (+ v) direction of the rotated coordinate system is shown by the radial tick mark.

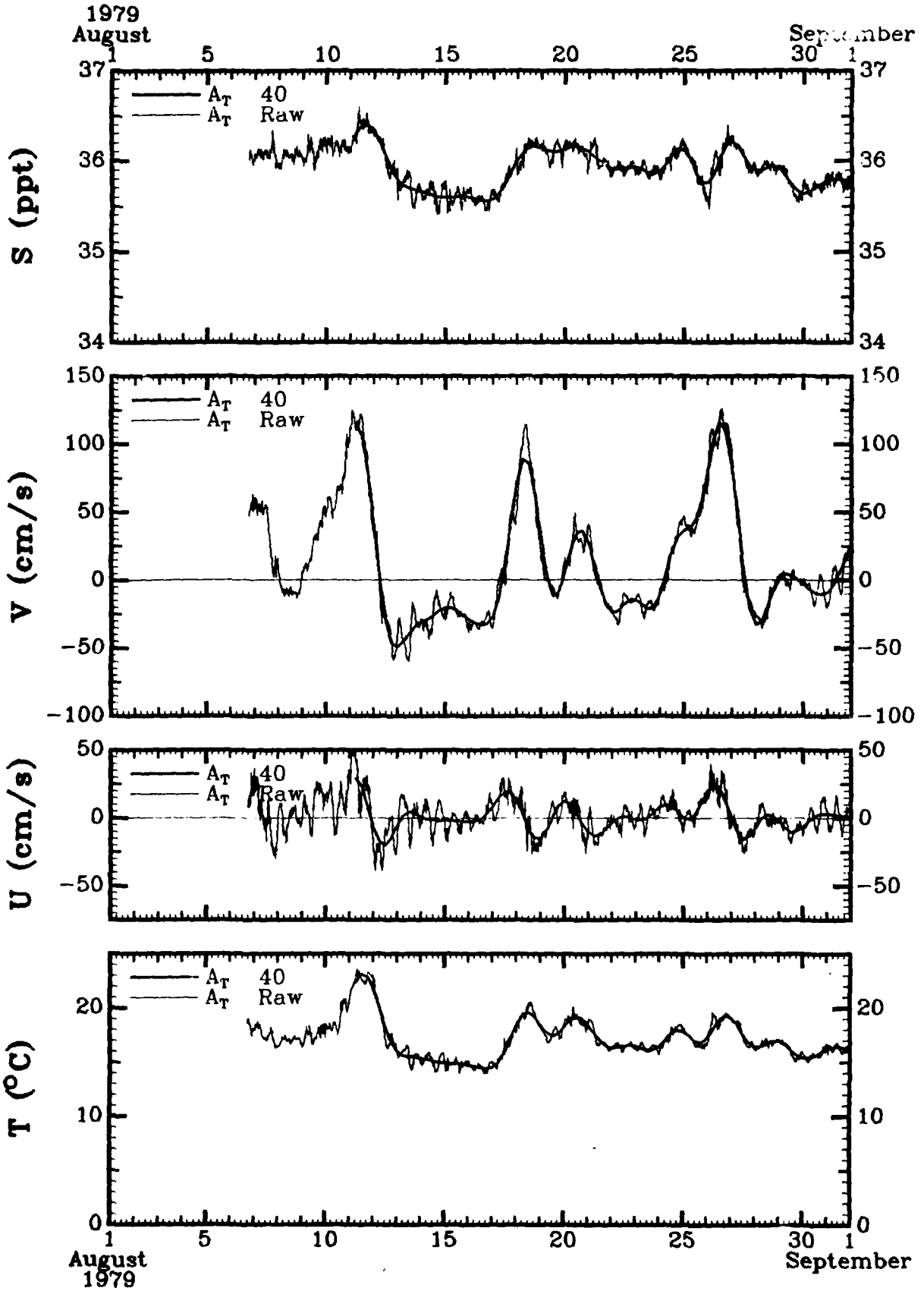
2.7 DATA PRESENTATION FORMATS

The current meter and atmospheric data sets are presented in the remainder of the report. Sections 3 through 5 show the current meter data in time series format and Section 6 shows the currents in "stick" plot format. Sections 7 and 8 show various combinations of the two data sets in time series format. All times in this report are given in Greenwich Mean Time (GMT). Section 9 shows the current meter data separately and in combination with other data sets in the frequency domain, giving spectrum, cross-spectrum, phase, and coherence information. All spectrum calculations employed the Cooley-Tukey method; that is, Fourier transformation of correlation functions. All frequency domain calculations in this report were carried out with an effective bandwidth of 0.033 cycles per day (CPD), to facilitate intercomparison. Current meter spectrum estimates nominally carry 15 degrees of freedom (DOF), although this number varies somewhat because of early termination of several records. For 15 DOF, the 95% confidence interval on phase estimates is about ±(27, 18, 12) degrees for coherence squared values of (0.4, 0.6, 0.8).

SECTION 3

Raw and 40 HRLP Data for Each Instrument

Figures 15 through 22 show the raw and superimposed 40 HRLP current meter data separately by month for each instrument. Common scaling of similar data has been used throughout this section.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August
September
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30
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S (ppt)
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36
35
34
A_T 40
A_T Raw
V (cm/s)
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50
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−50
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U (cm/s)
T (°C)
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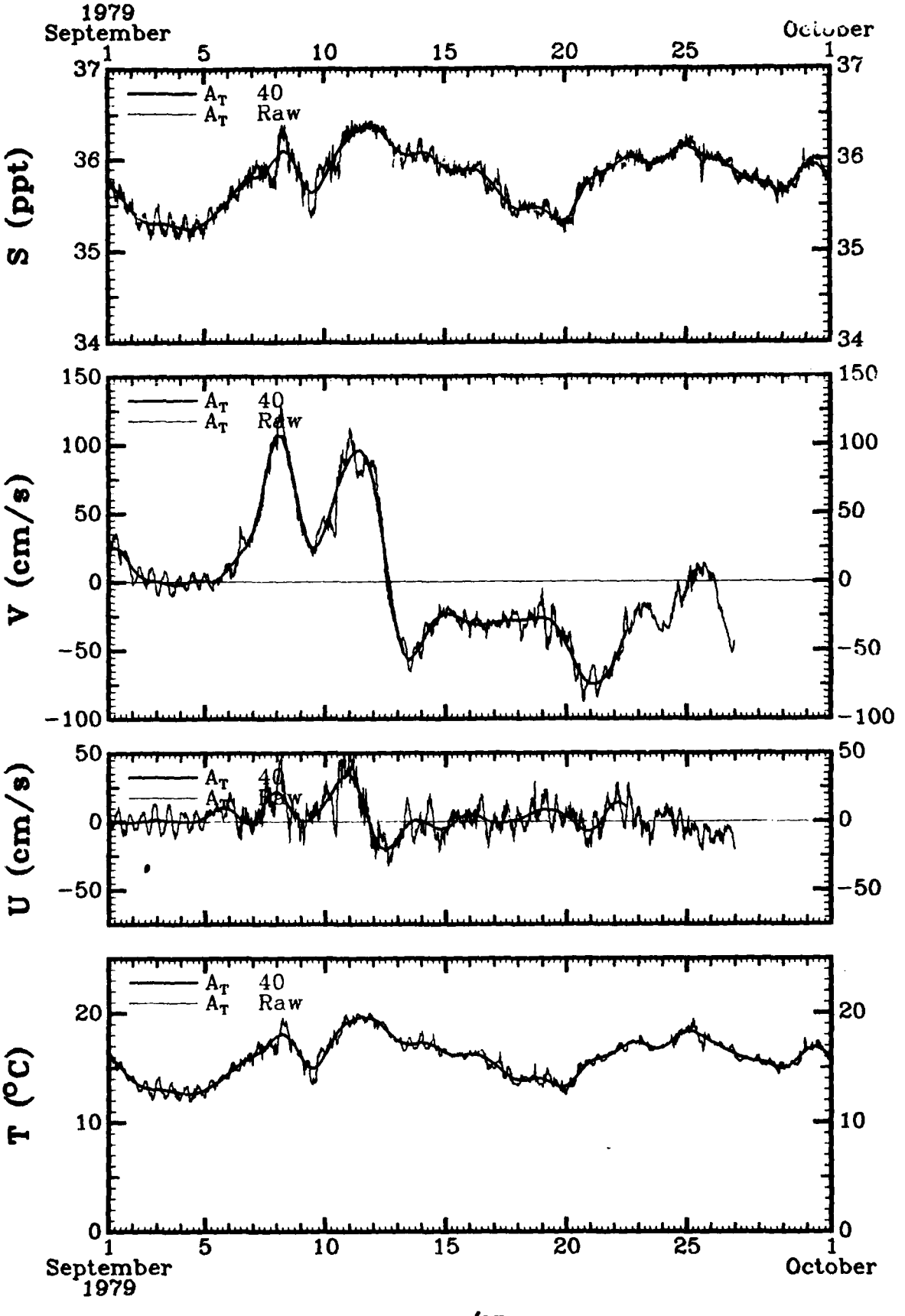
August
1979
September
Date/Time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A_T 40
A_T Raw
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V (cm/s)
U (cm/s)
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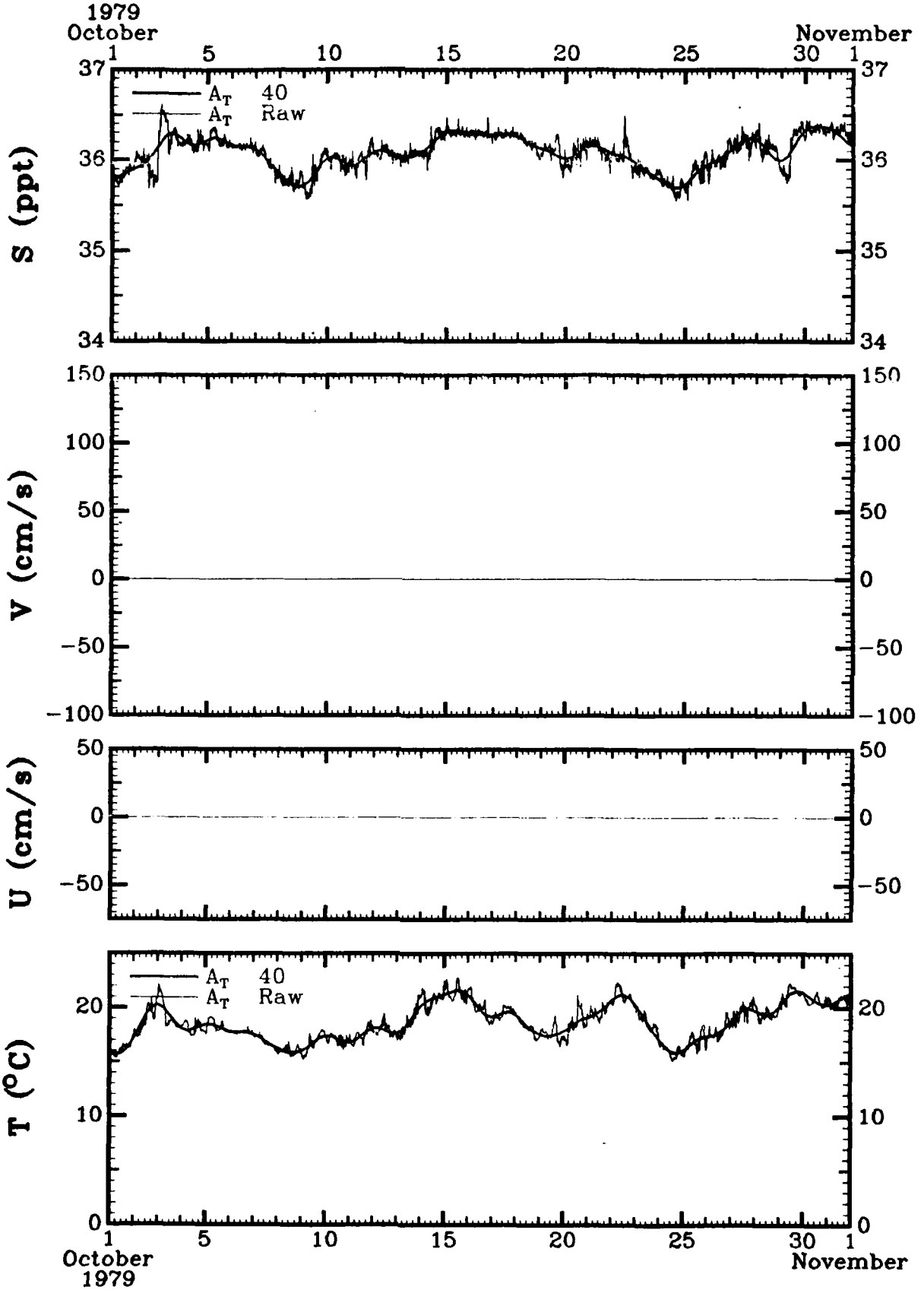
T (°C)
September
1979
October
Date/Time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October
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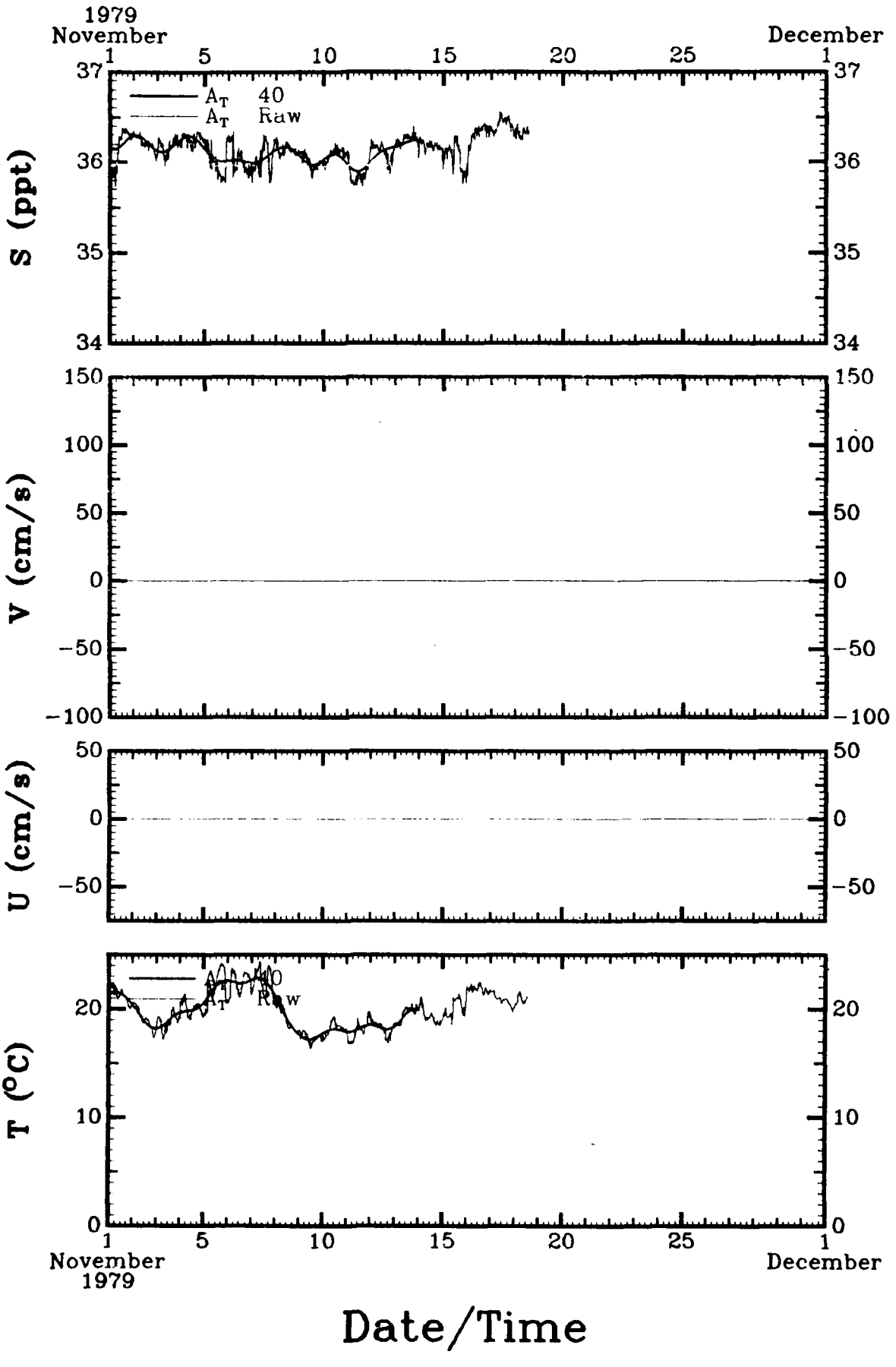
November
Date/Time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V (cm/s)
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November
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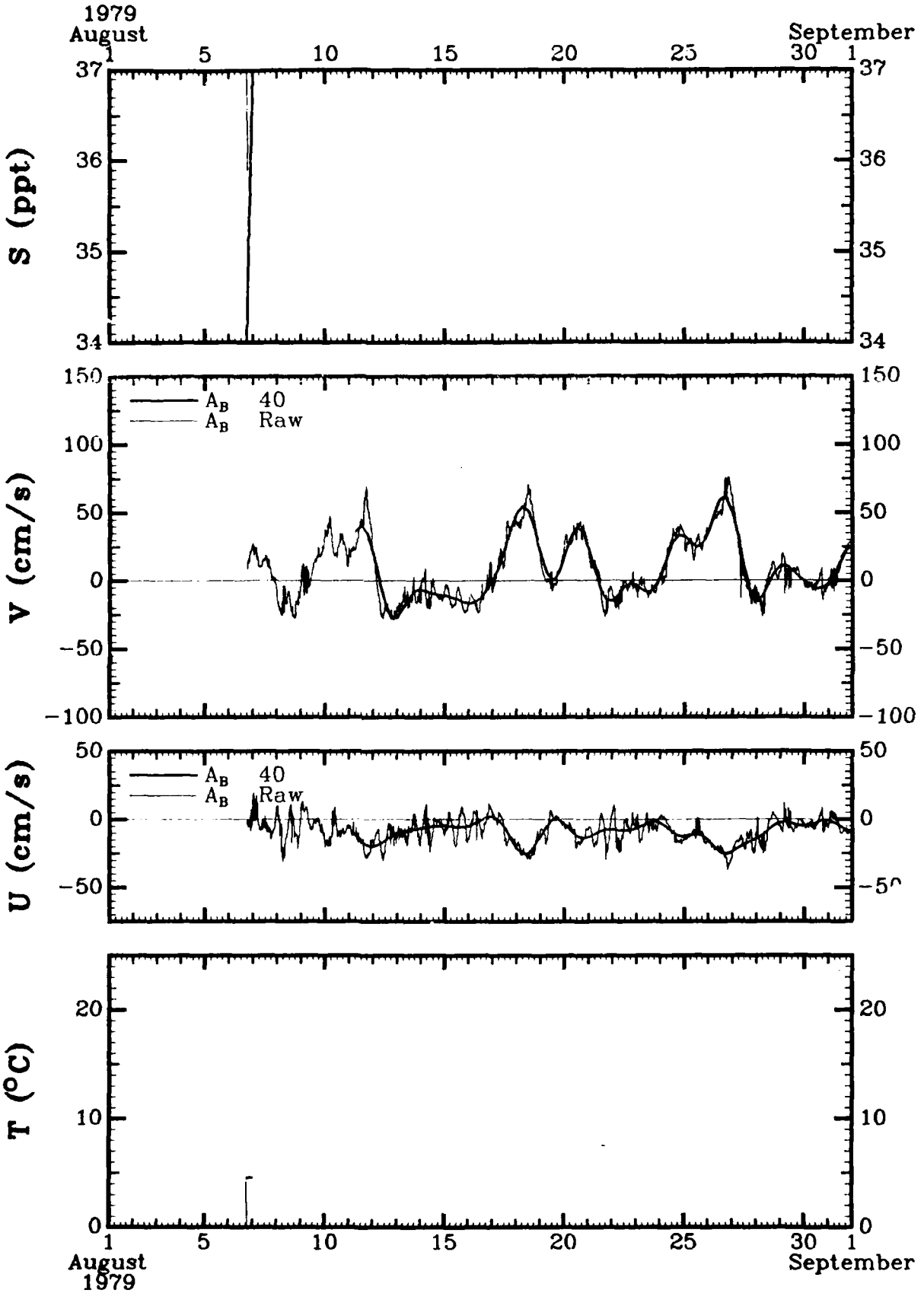
December
Date/Time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A_B Raw
U (cm/s)
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T (°C)
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August
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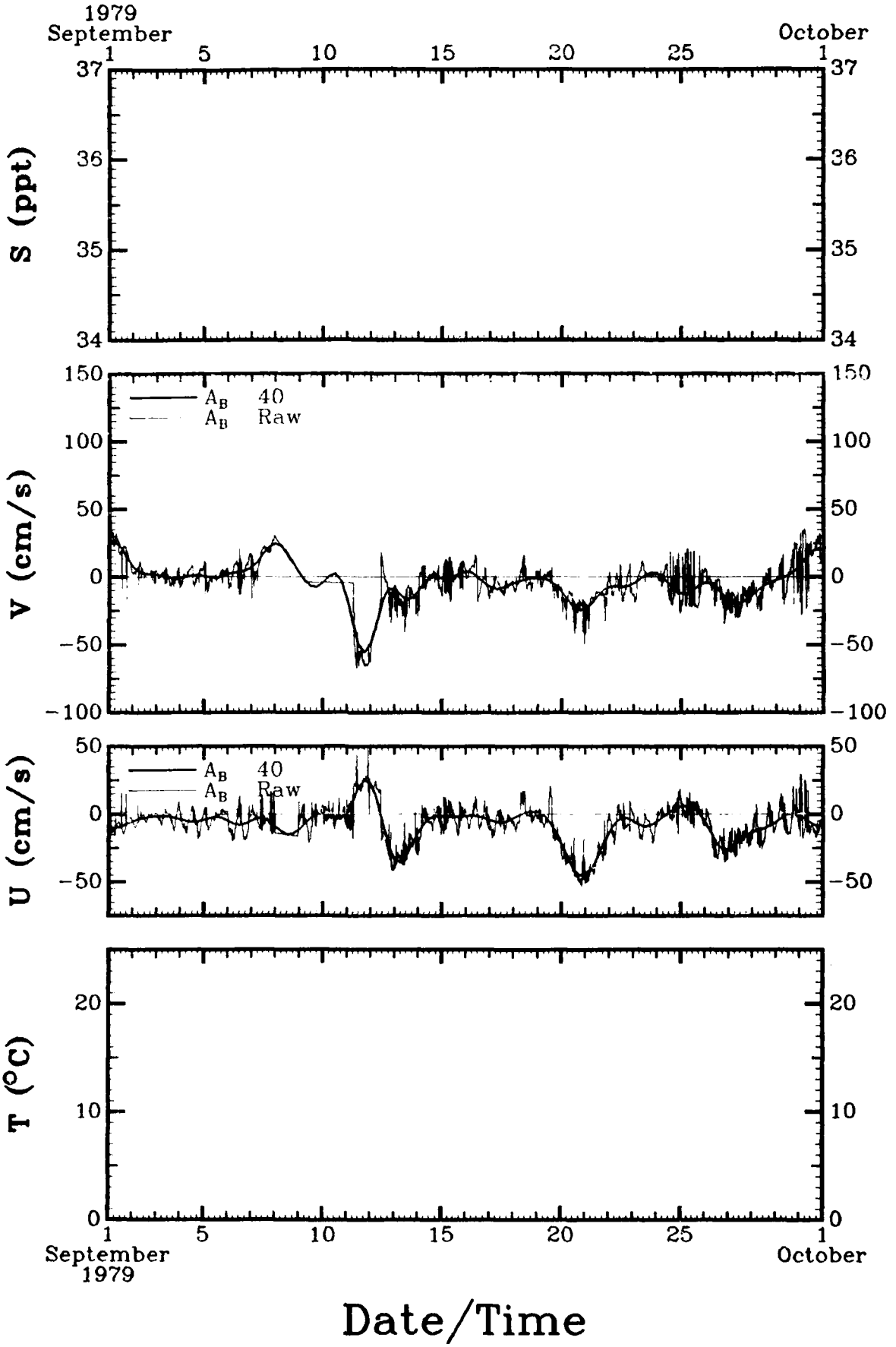
September
Date/Time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−100
A_B 40
A_B Raw
U (cm/s)
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−50
A_B 40
A_B Raw
T (°C)
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10
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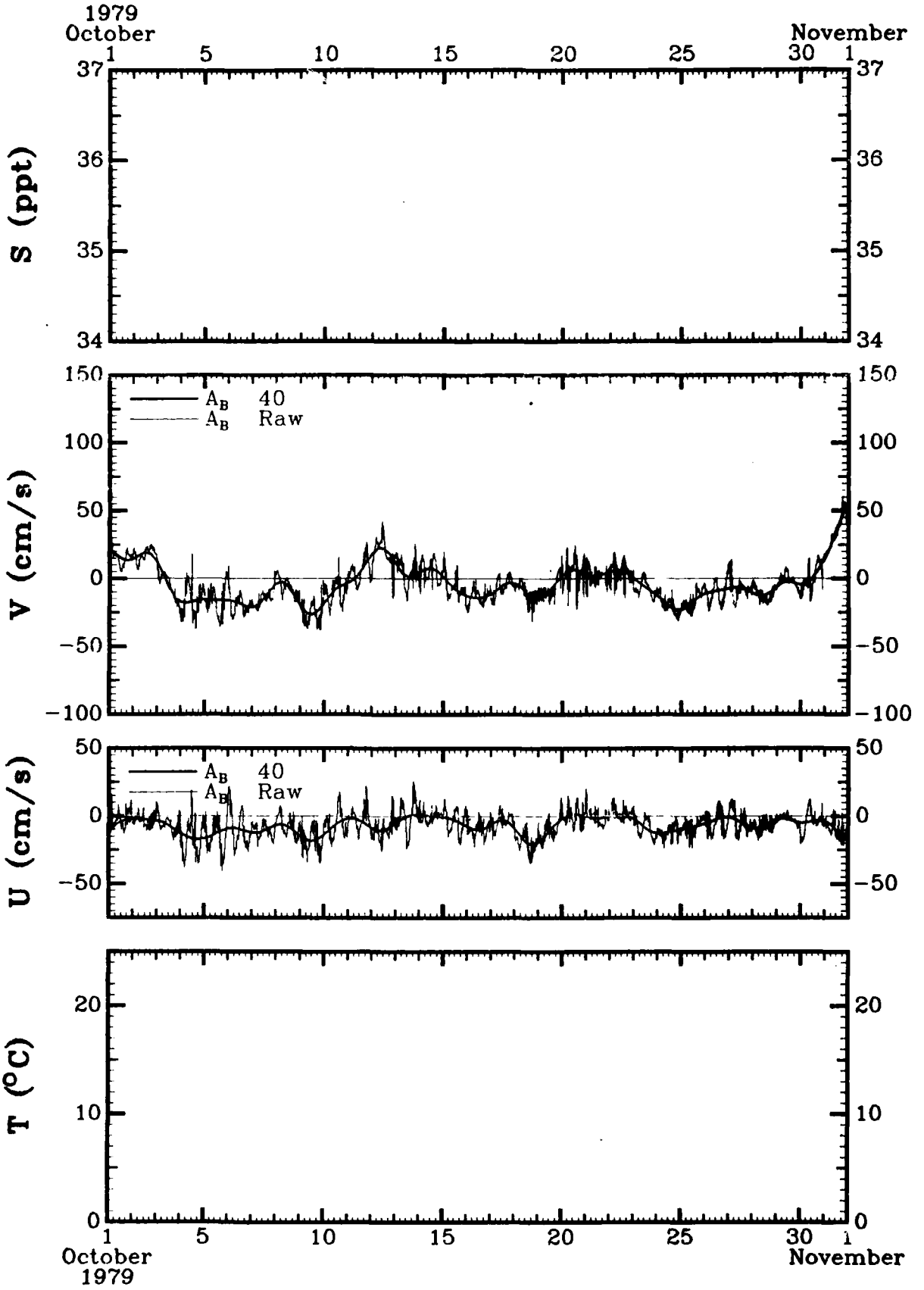
September
1979
Date/Time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S (ppt)
150
100
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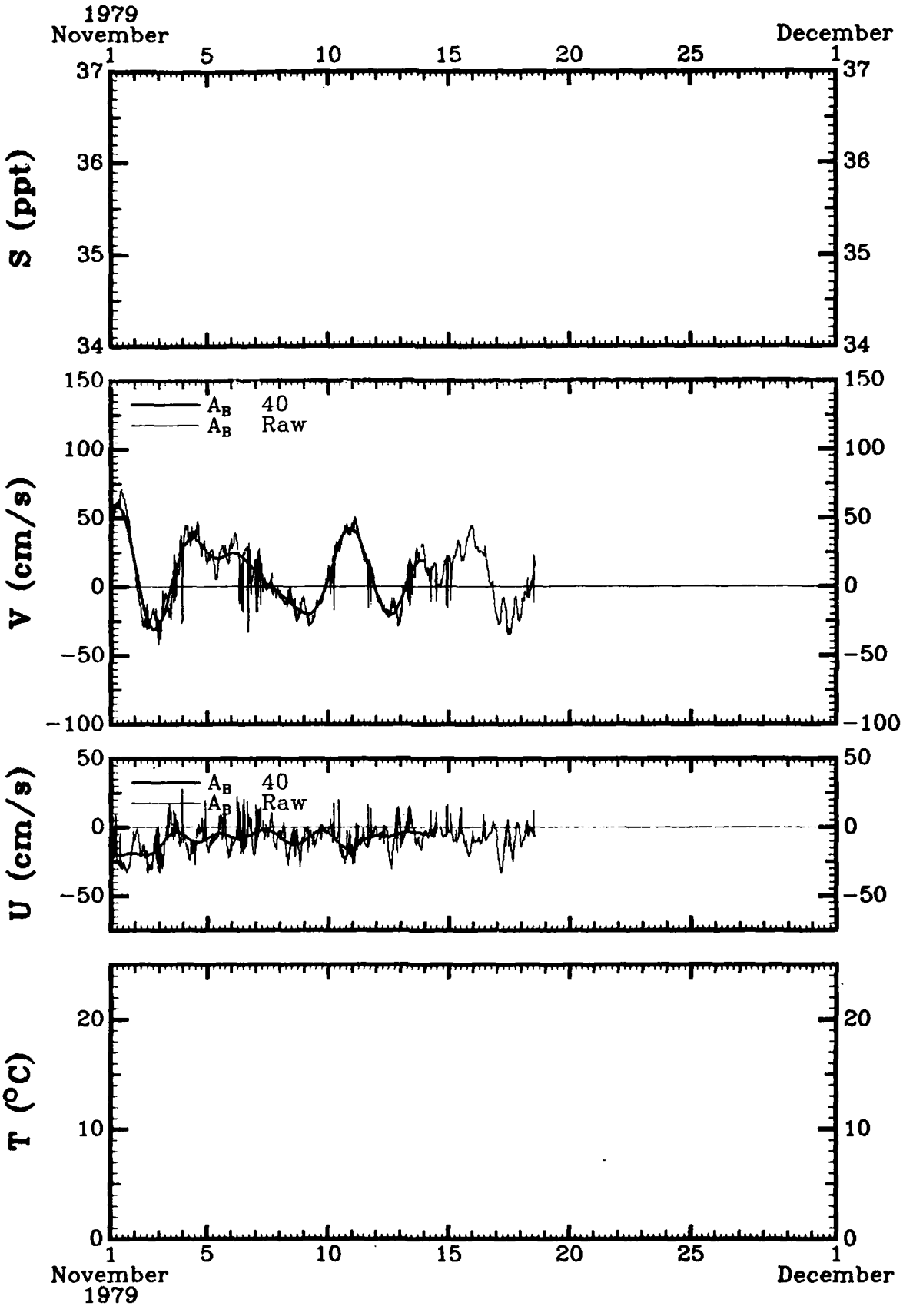
0
−50
−100
V (cm/s)
A_B 40
A_B Raw
U (cm/s)
20
10
0
T (°C)
October
1979
November
Date/Time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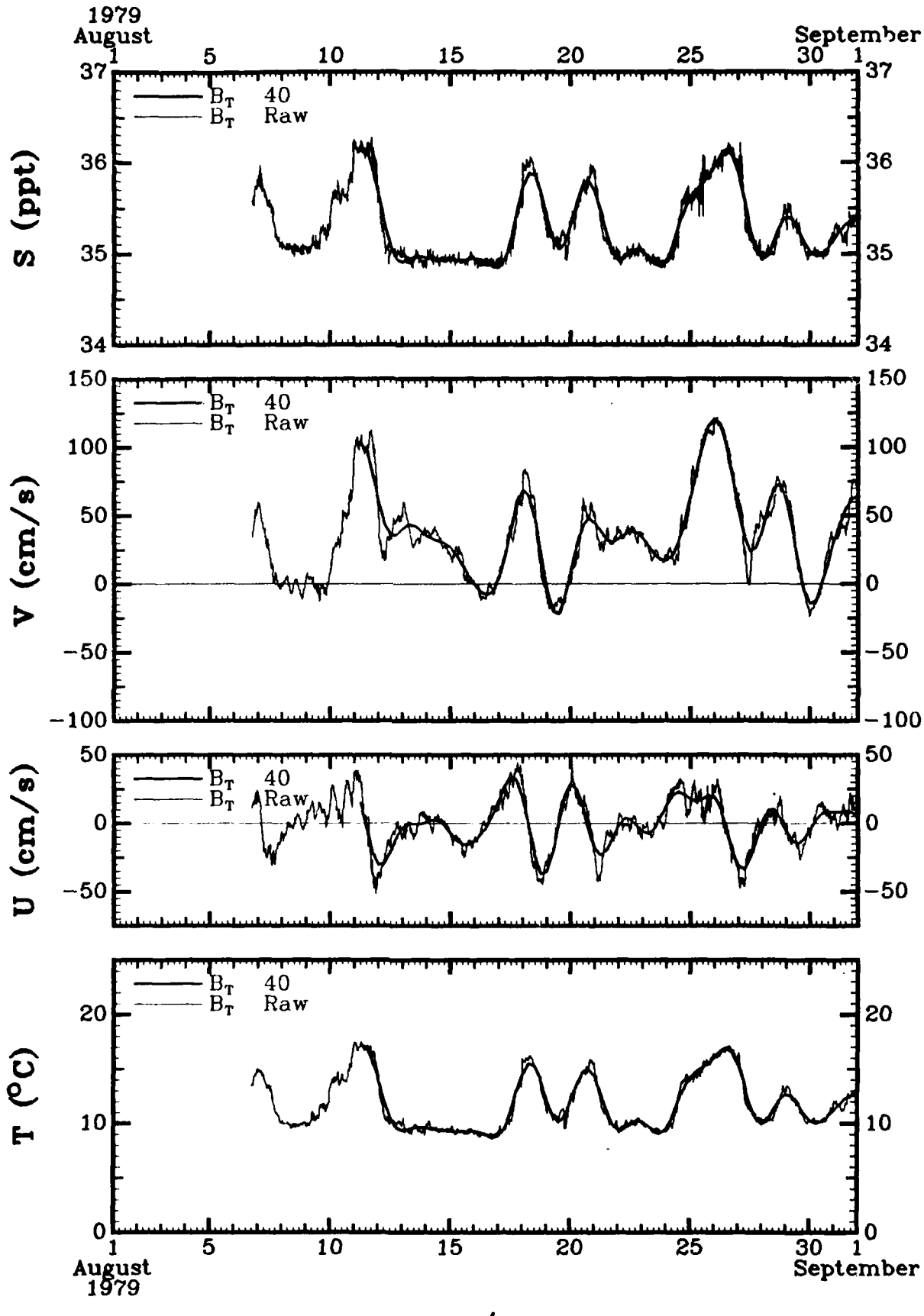
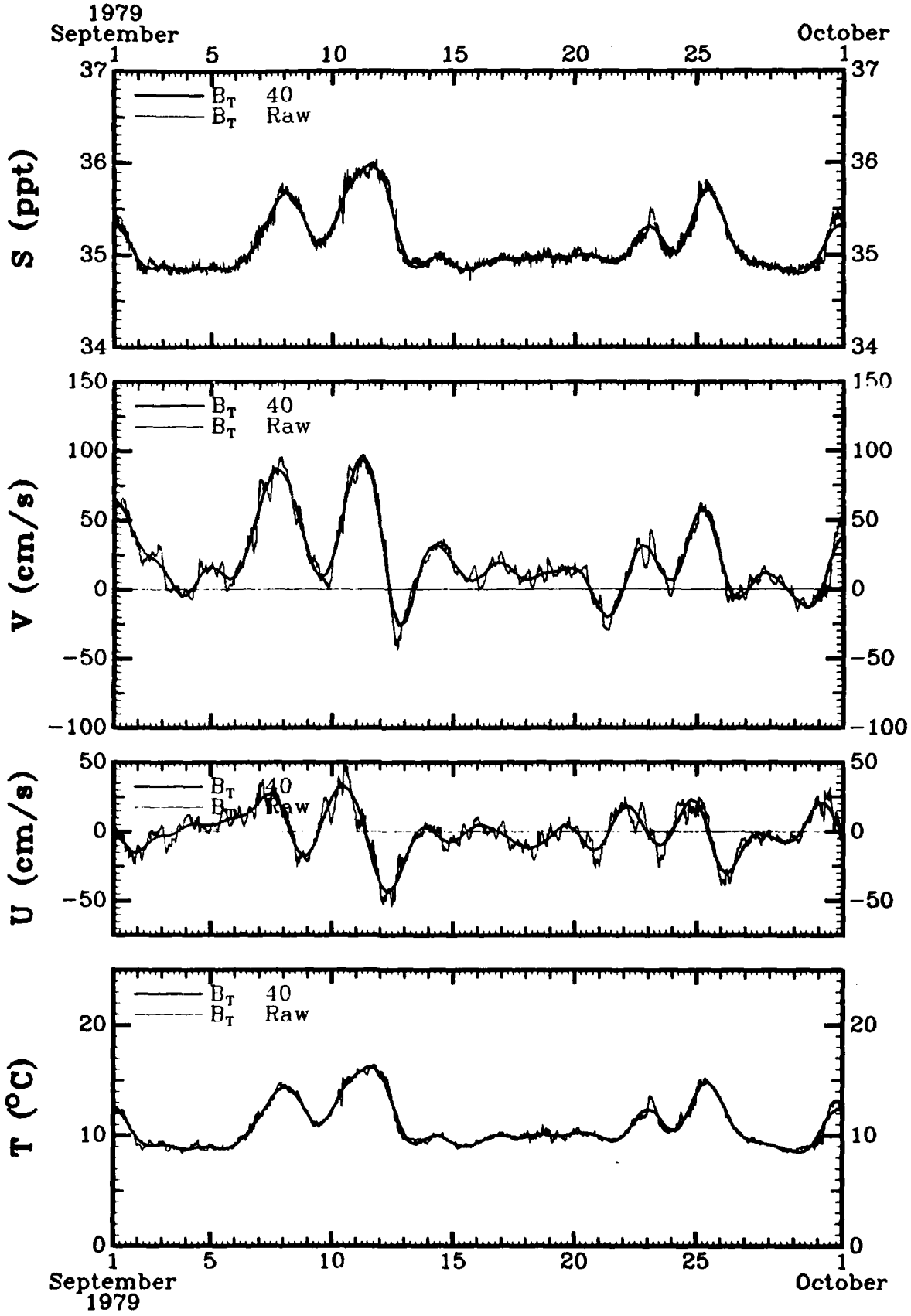
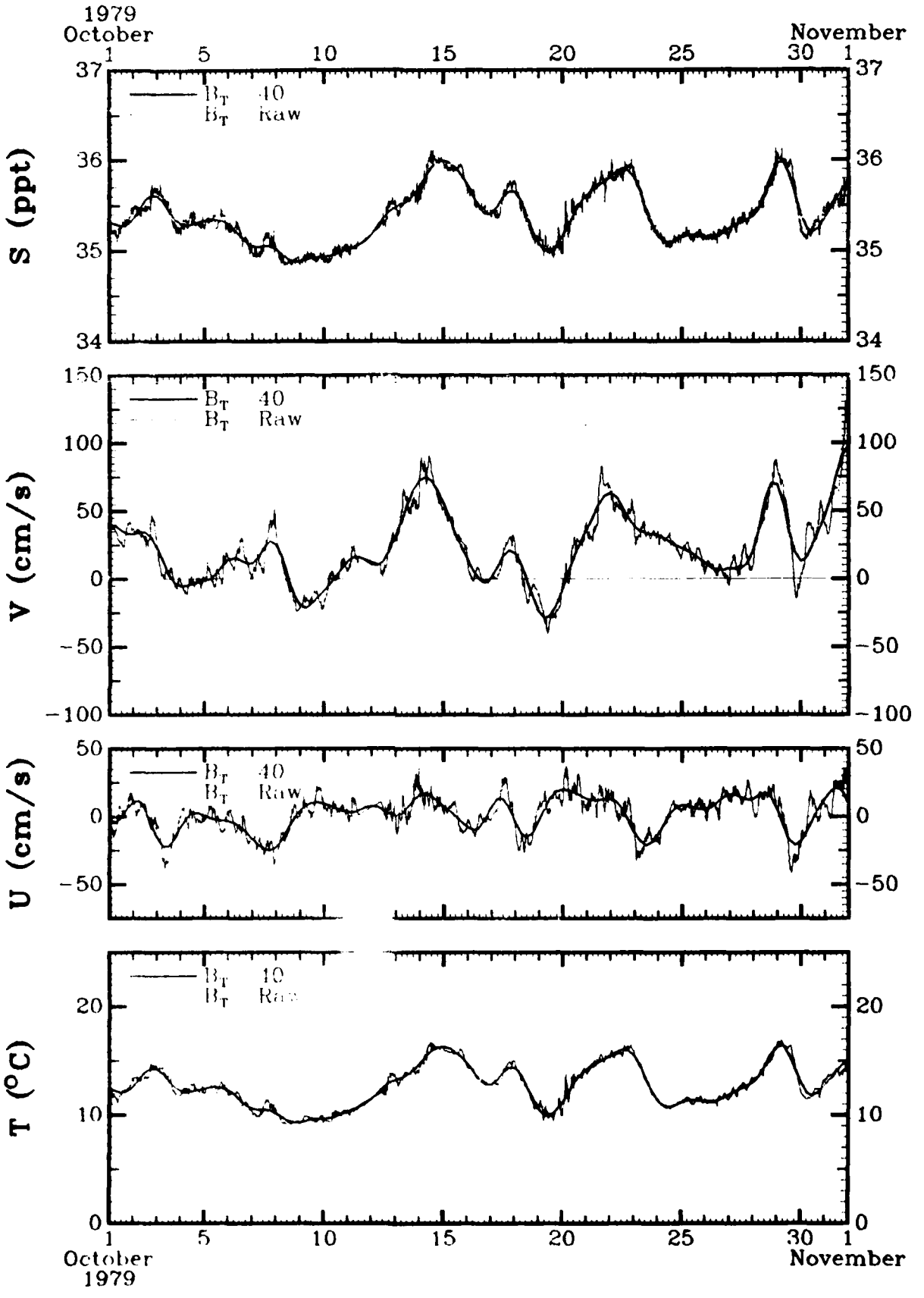
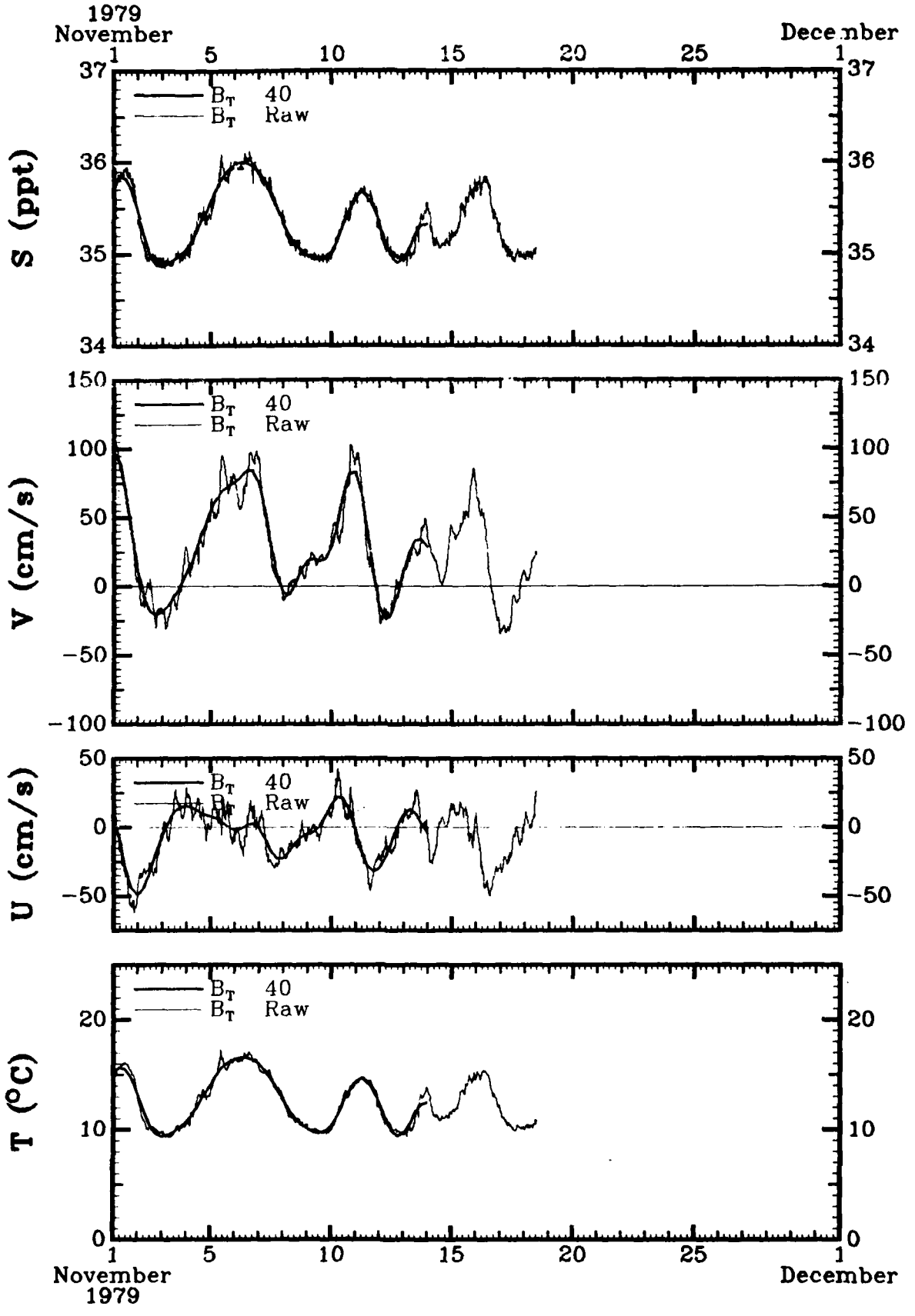
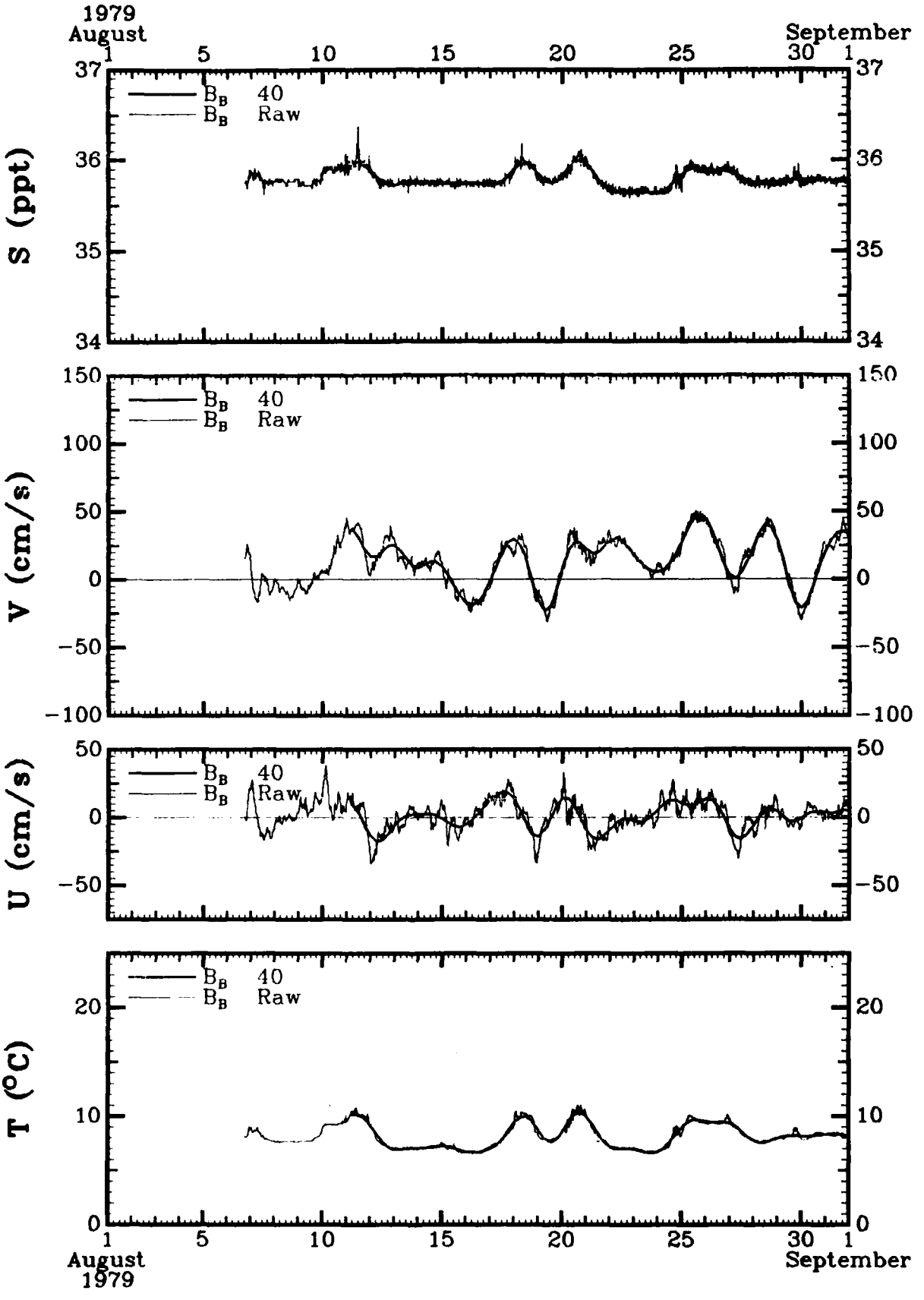
December
S (ppt)
V (cm/s)
U (cm/s)
T (°C)
A_B 40
A_B Raw
Date/Time

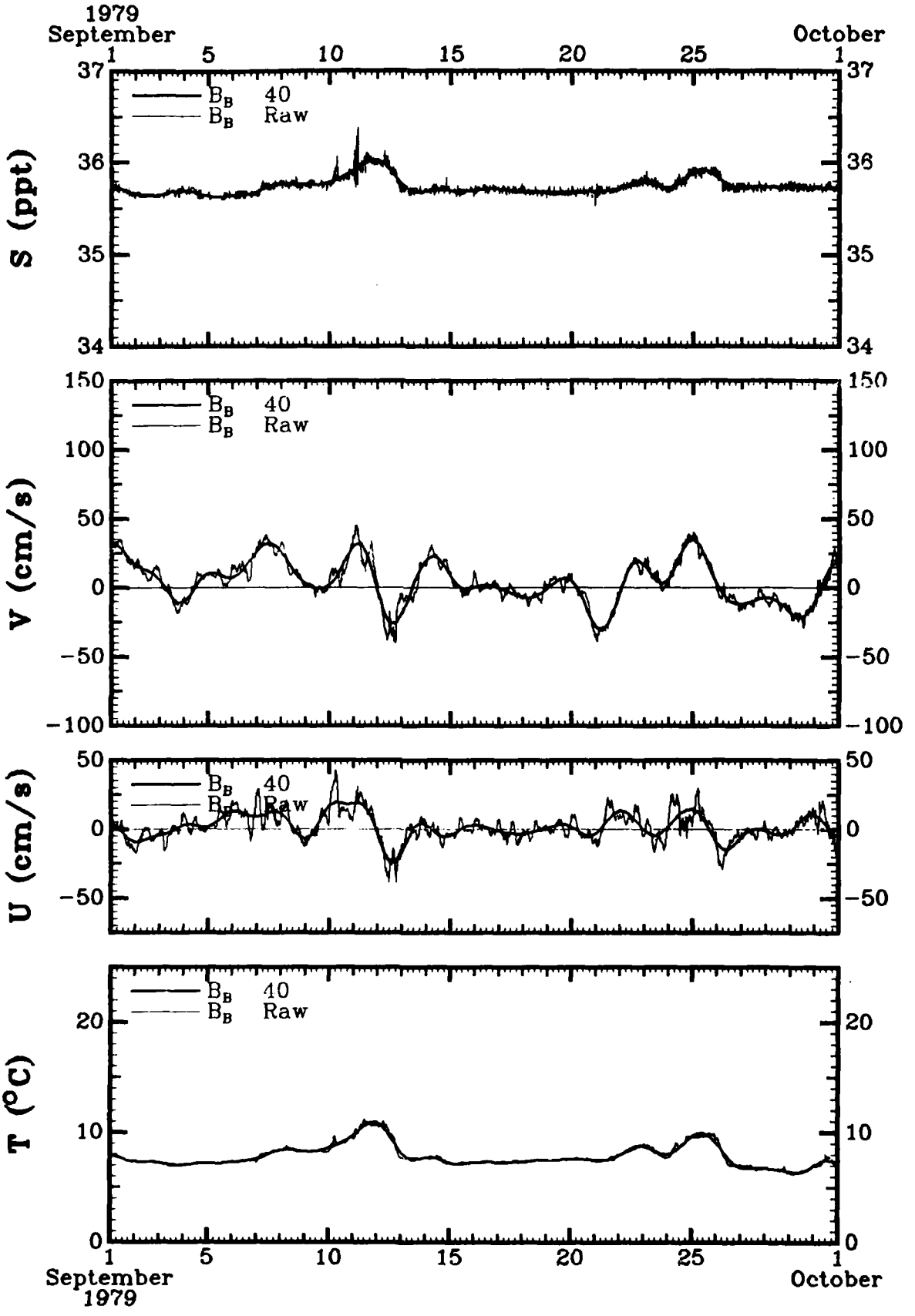

1979
August
September
1
5
10
15
20
25
30
1
S (ppt)
37
36
35
34
B_T 40
B_T Raw
V (cm/s)
150
100
50
0
−50
−100
U (cm/s)
T (°C)
20
10
0
August
1979
Date/Time

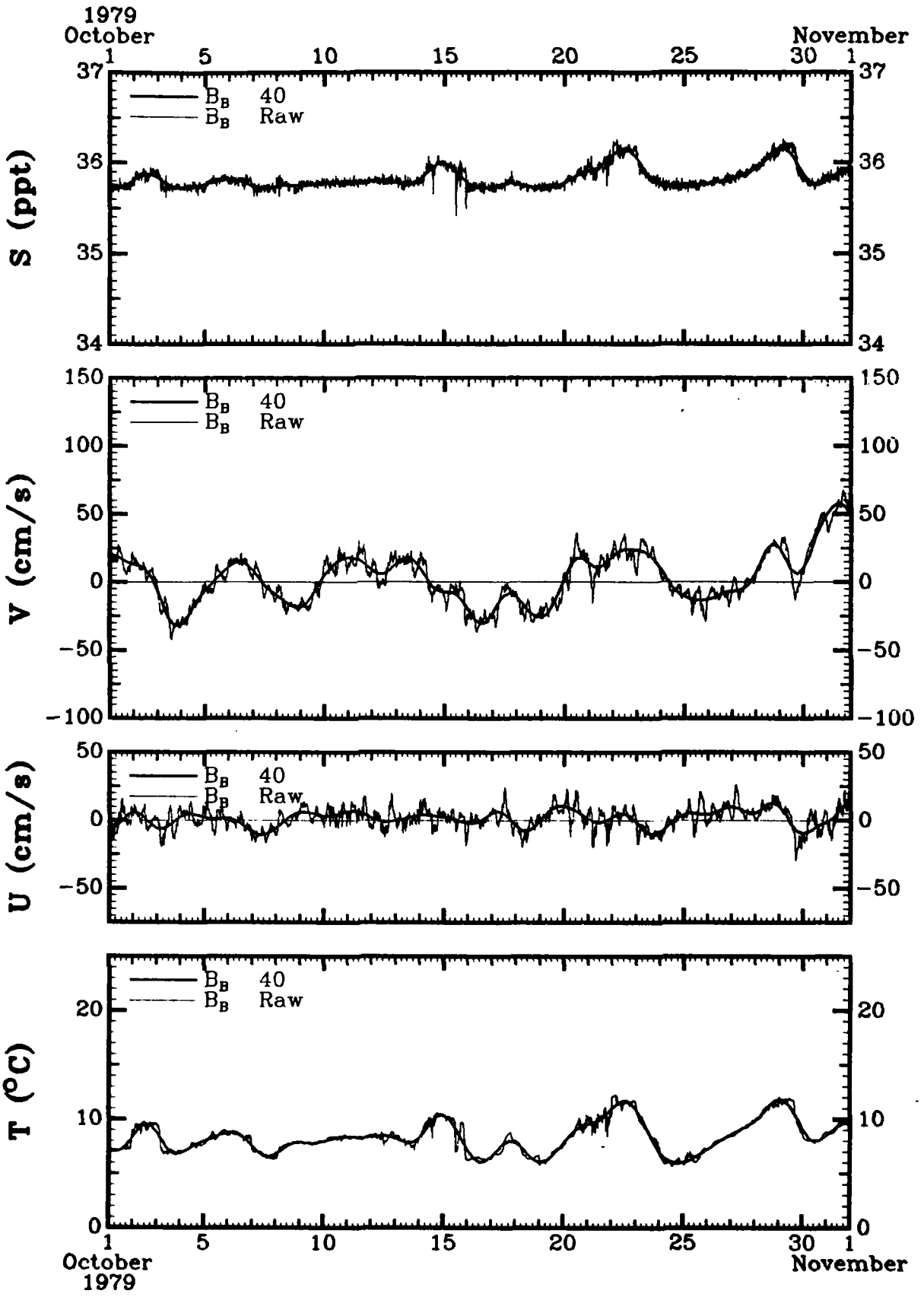

1979
September
October
1
5
10
15
20
25
1
S (ppt)
37
36
35
34
B_T 40
B_T Raw
V (cm/s)
150
100
50
0
−50
−100
U (cm/s)
T (°C)
20
10
0
September
1979
Date/Time

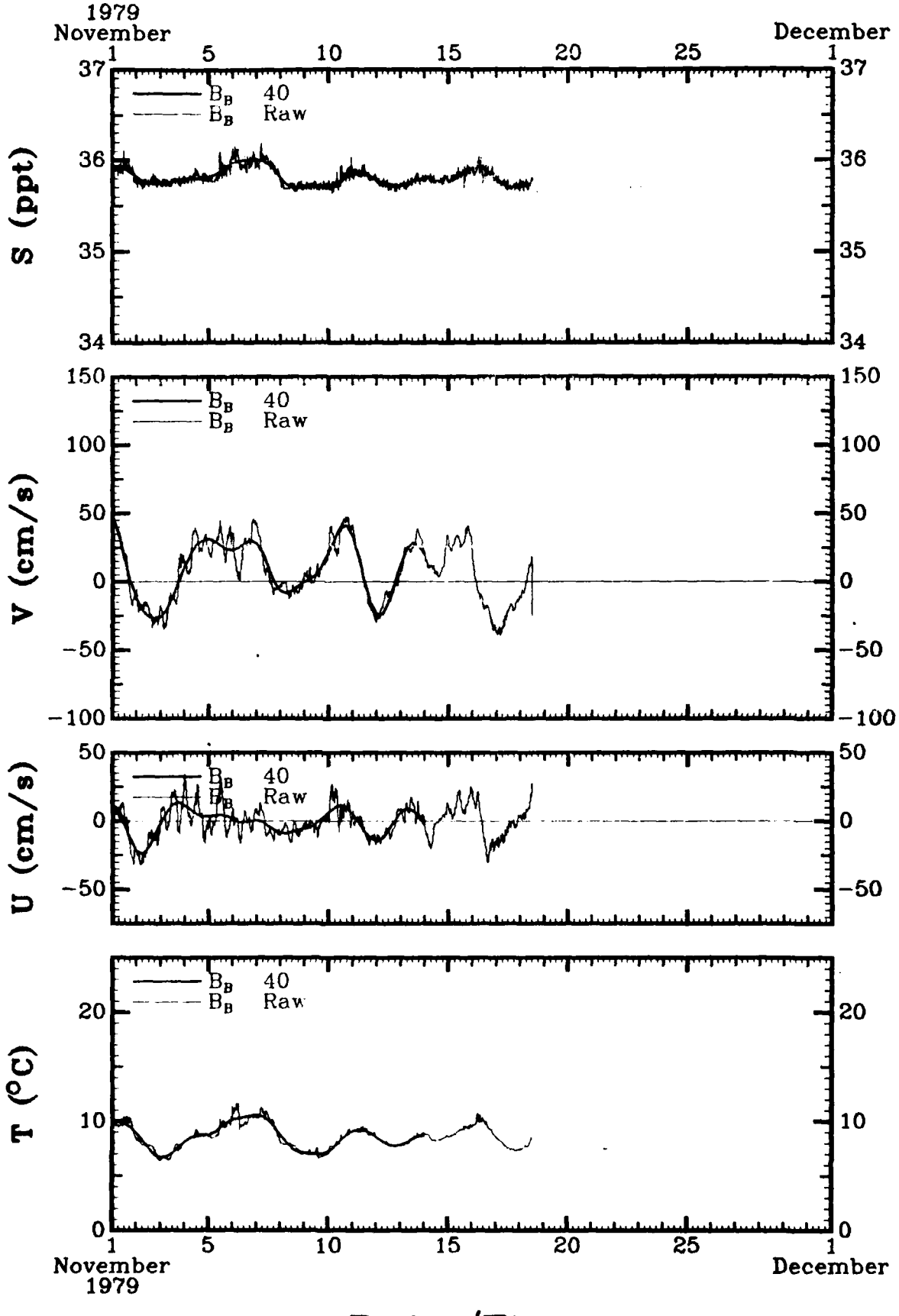

1979
October
November
1
5
10
15
20
25
30
1
S (ppt)
37
36
35
34
B_T 40
B_T Raw
V (cm/s)
150
100
50
0
−50
−100
U (cm/s)
T (°C)
20
10
0
October
1979
November
Date/Time

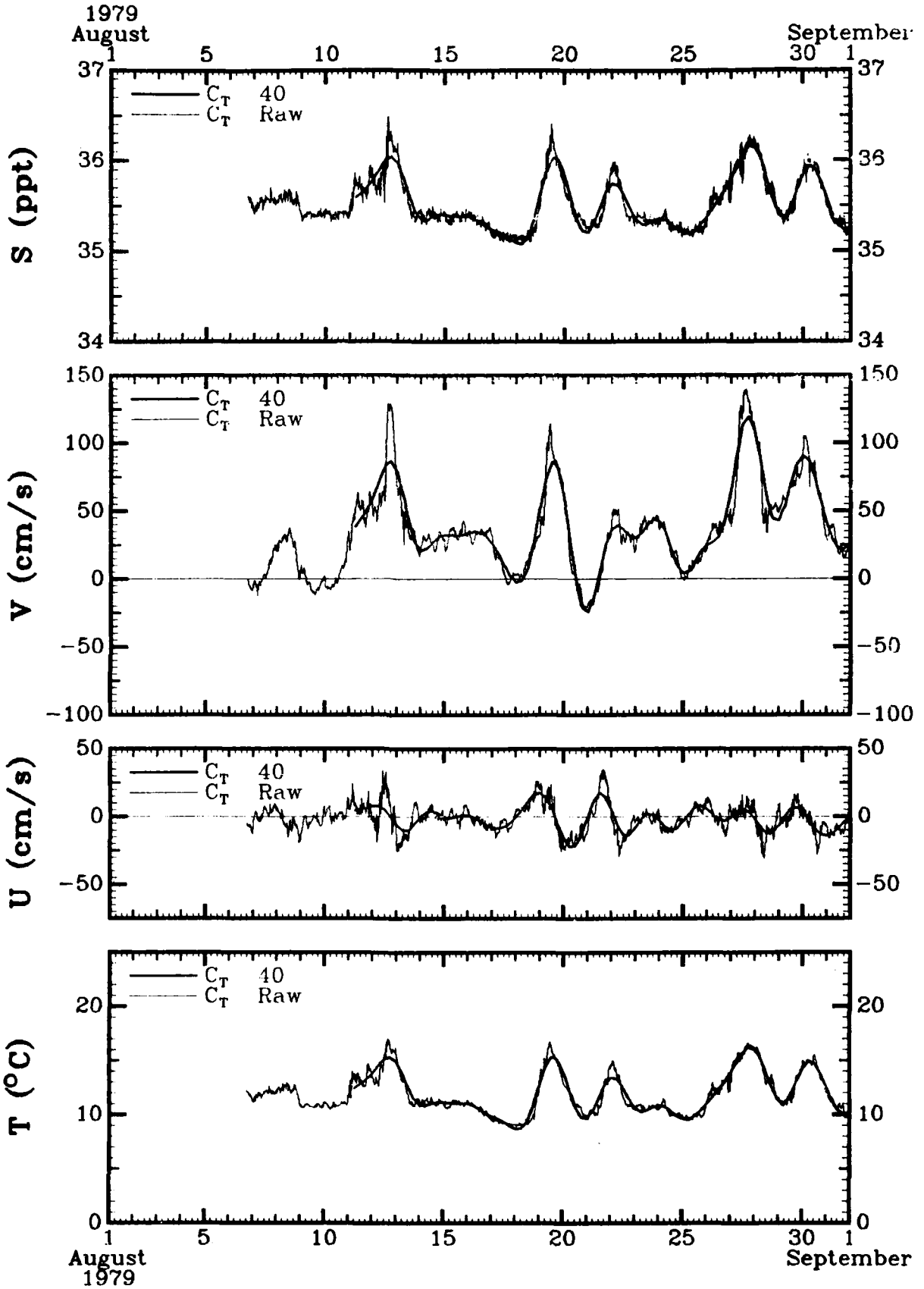

1979
November
December
1
5
10
15
20
25
1
S (ppt)
37
36
35
34
B_T 40
B_T Raw
V (cm/s)
150
100
50
0
−50
−100
U (cm/s)
T (°C)
20
10
0
November
1979
December
Date/Time

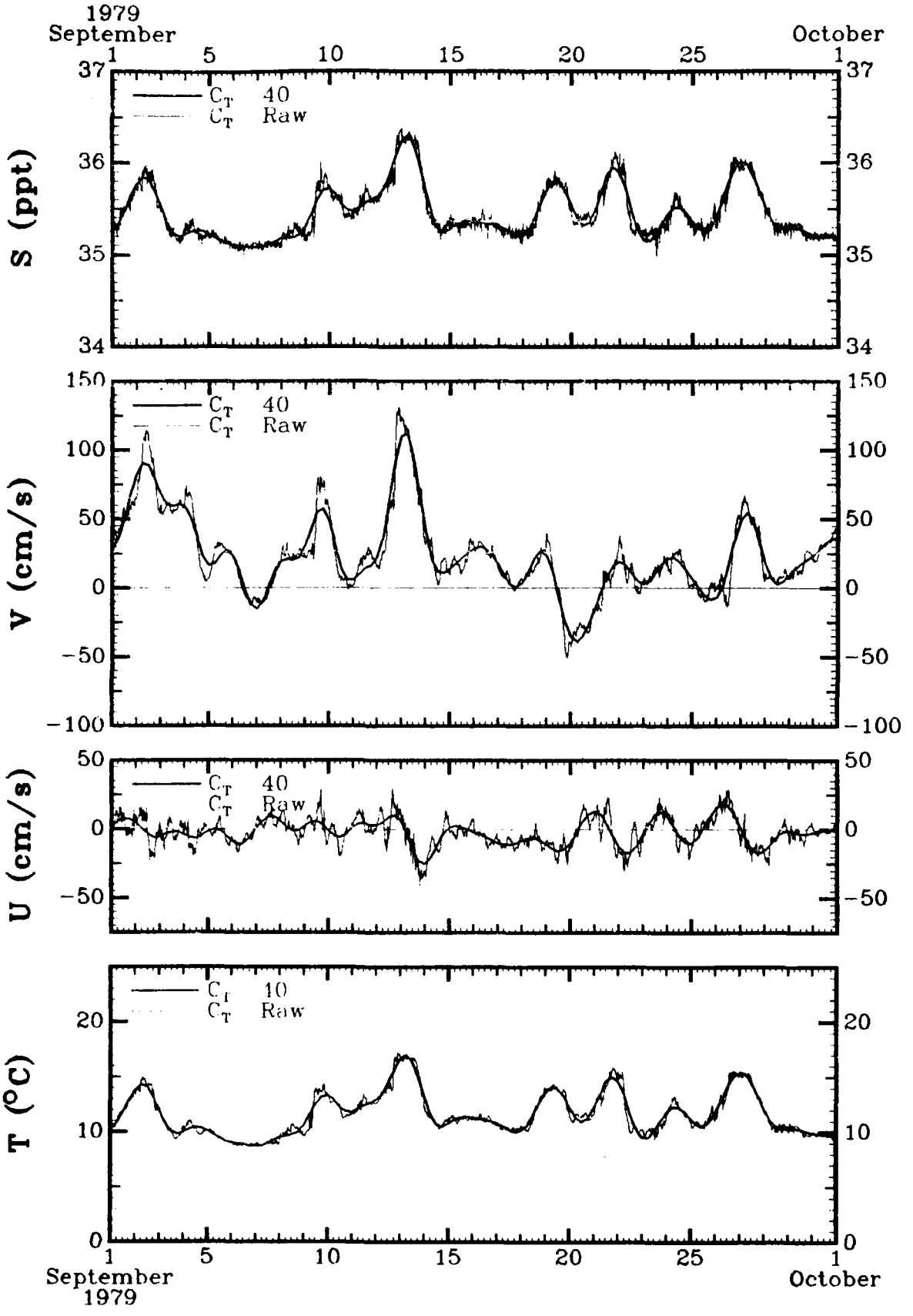

1979
August
September
1
5
10
15
20
25
30
1
S (ppt)
37
36
35
34
B_B 40
B_B Raw
V (cm/s)
150
100
50
0
−50
−100
U (cm/s)
T (°C)
20
10
0
August
1979
Date/Time

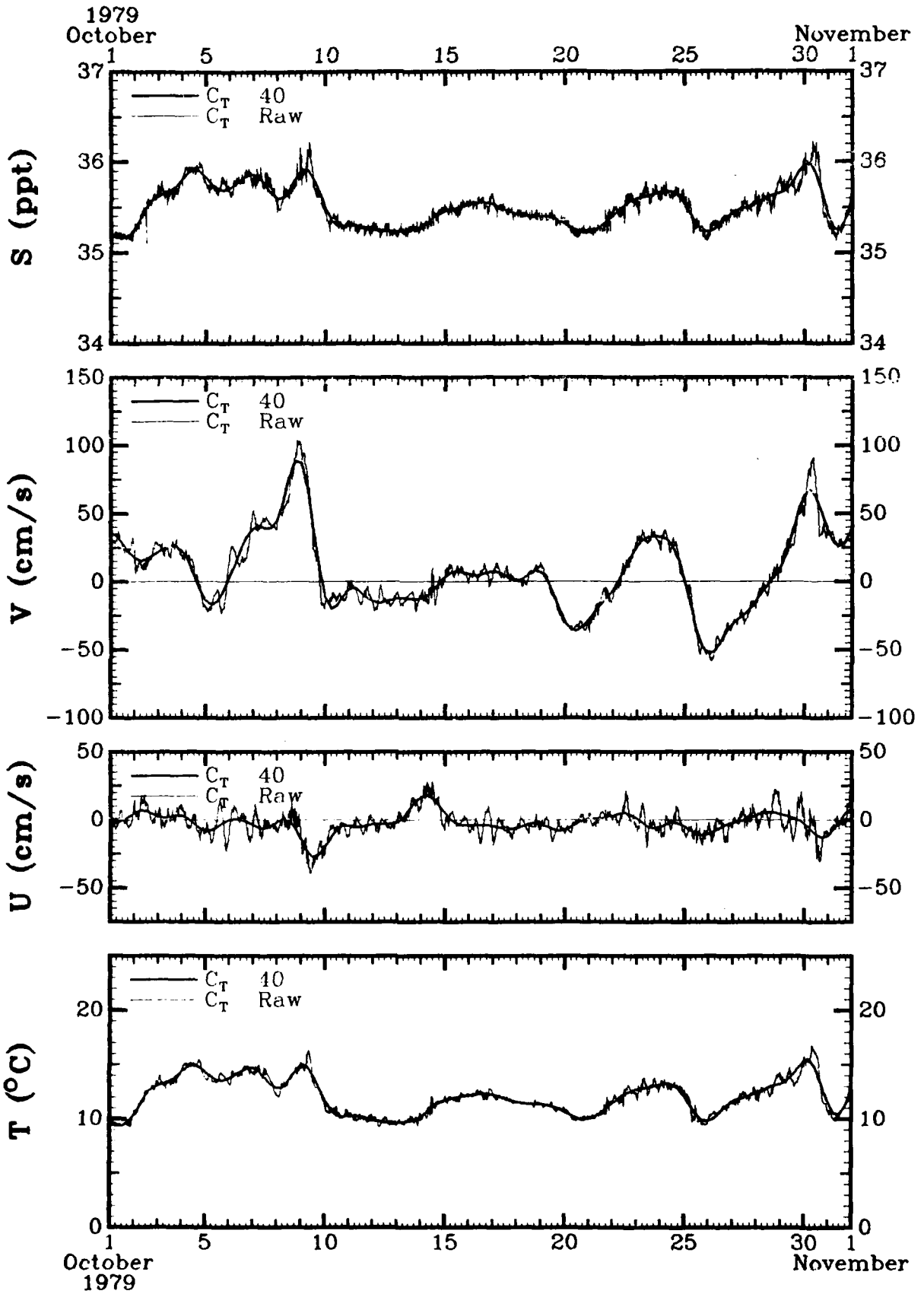

1979
September
October
1
5
10
15
20
25
1
37
36
35
34
S (ppt)
B_B 40
B_B Raw
150
100
50
0
−50
−100
V (cm/s)
50
0
−50
U (cm/s)
20
10
0
T (°C)
September
1979
Date/Time

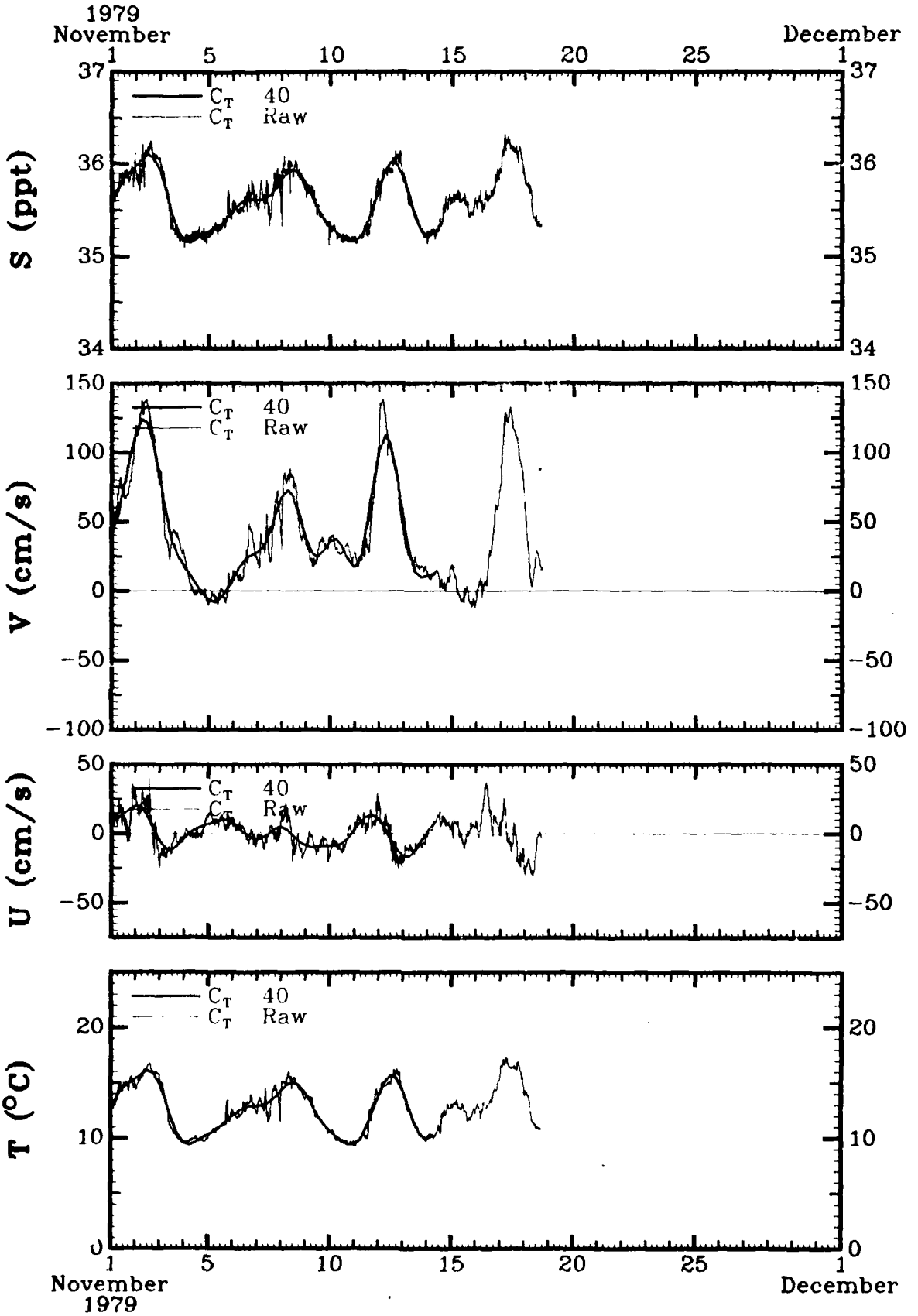

1979
October
November
1
5
10
15
20
25
30
1
37
36
35
34
S (ppt)
B_B 40
B_B Raw
150
100
50
0
−50
−100
V (cm/s)
U (cm/s)
20
10
T (°C)
October
1979
November
Date/Time

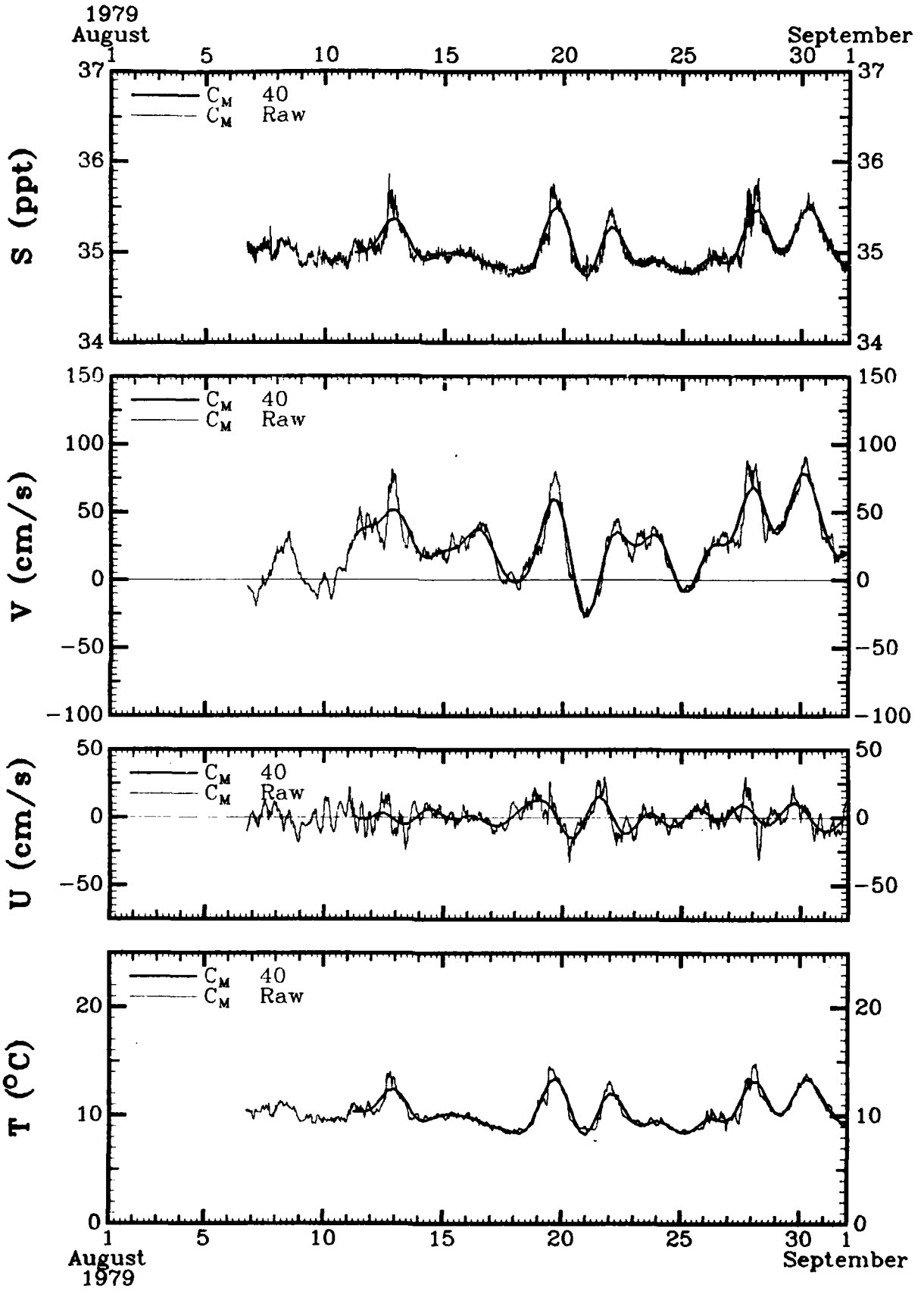

1979
November
December
1
5
10
15
20
25
1
S (ppt)
37
36
35
34
B_B 40
B_B Raw
V (cm/s)
150
100
50
0
−50
−100
U (cm/s)
50
0
−50
T (°C)
20
10
0
November
1979
December
Date/Time

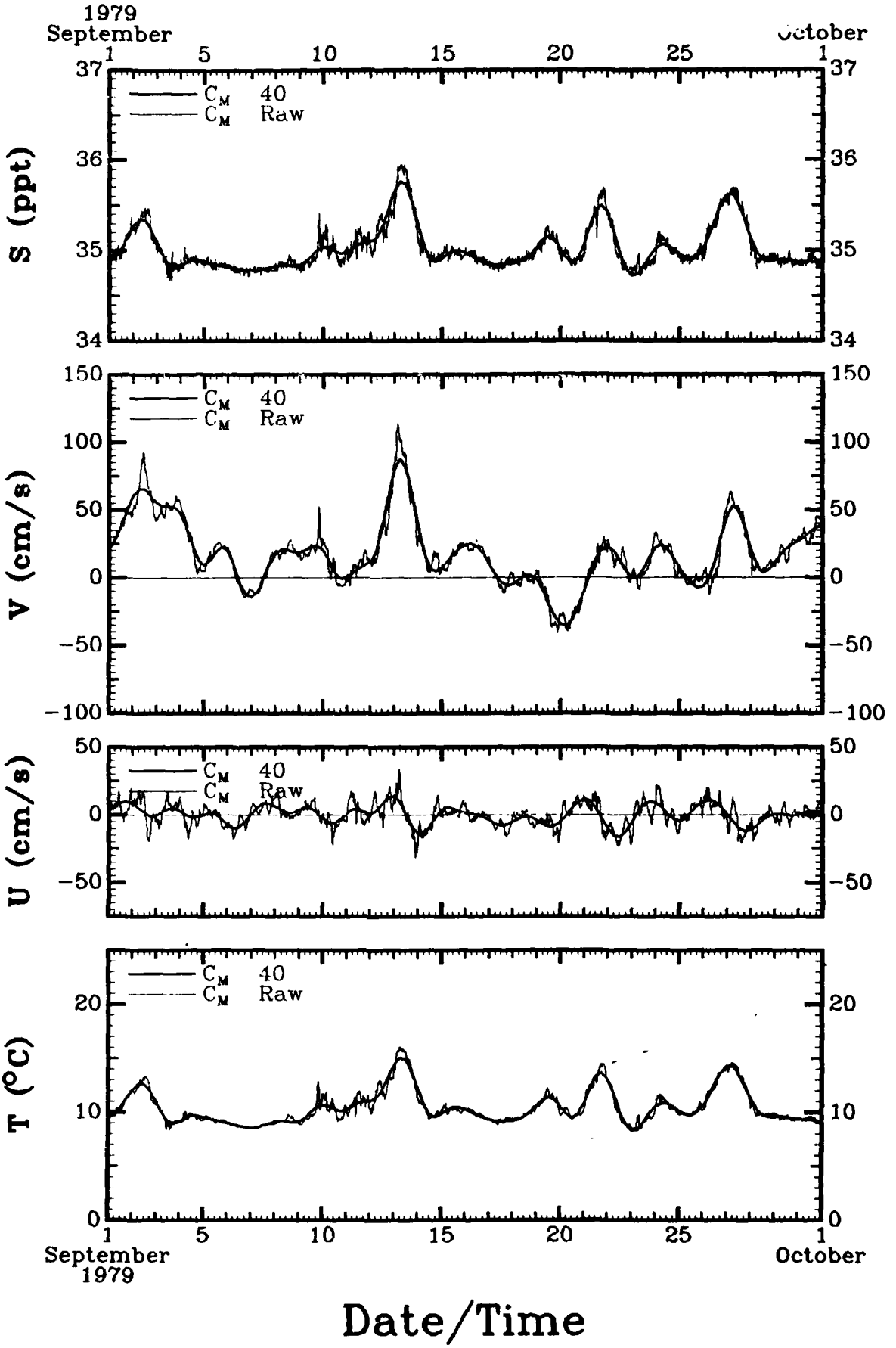

1979
August
September
1
5
10
15
20
25
30
1
S (ppt)
37
36
35
34
C_T 40
C_T Raw
V (cm/s)
150
100
50
0
−50
−100
U (cm/s)
T (°C)
20
10
0
August
1979
September
Date/Time

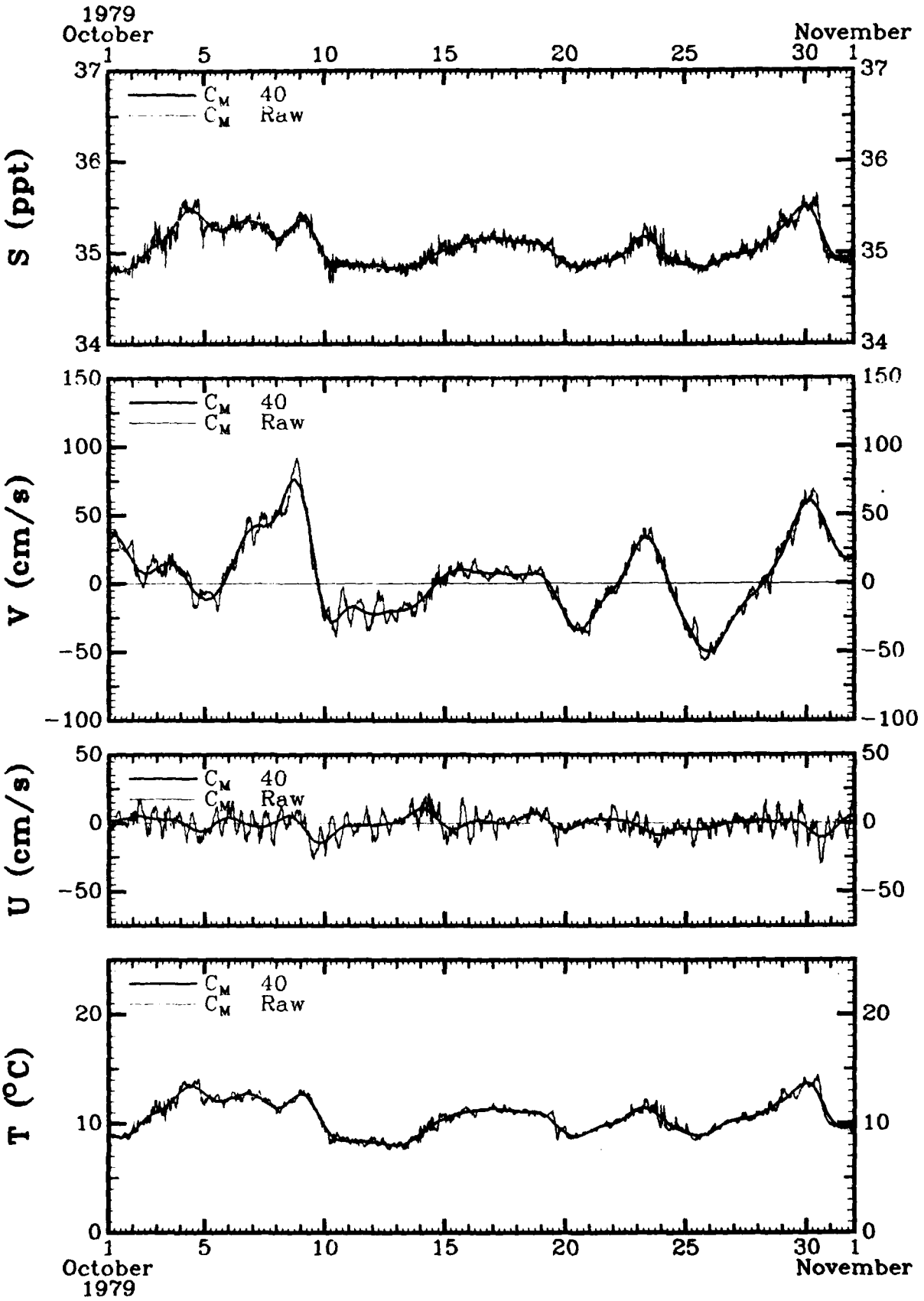

1979
September
October
1
5
10
15
20
25
1
S (ppt)
37
36
35
34
C_T 40
C_T Raw
V (cm/s)
150
100
50
0
−50
−100
U (cm/s)
T (°C)
20
10
0
September
1979
Date/Time

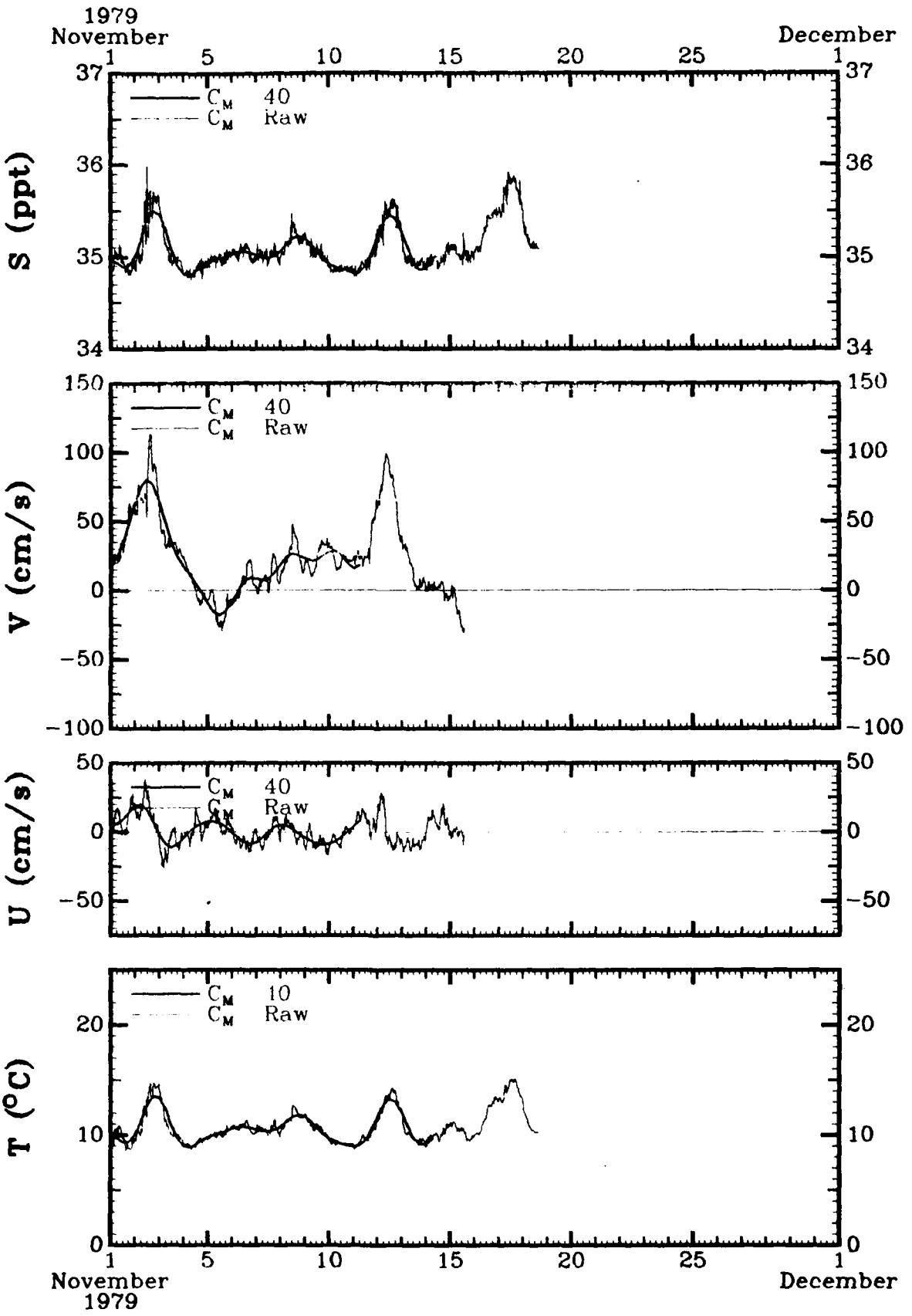

1979
October
November
1
5
10
15
20
25
30
1
S (ppt)
37
36
35
34
C_T 40
C_T Raw
V (cm/s)
150
100
50
0
−50
−100
U (cm/s)
T (°C)
20
10
0
October
1979
November
Date/Time

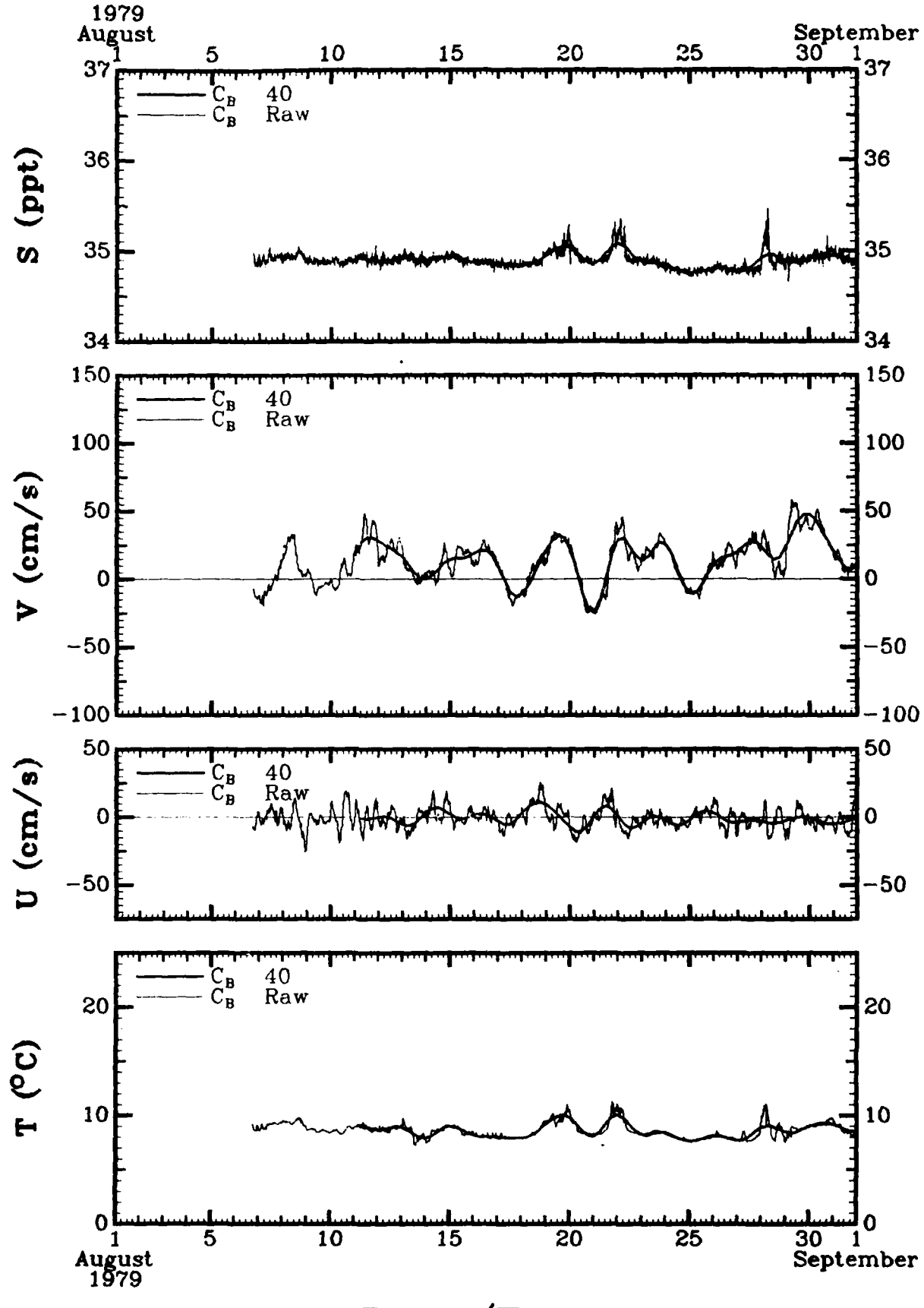

1979
November
December
1
5
10
15
20
25
1
37
36
35
34
S (ppt)
C_T 40
C_T Raw
150
100
50
0
−50
−100
V (cm/s)
50
0
−50
U (cm/s)
20
10
0
T (°C)
November
1979
December
Date/Time

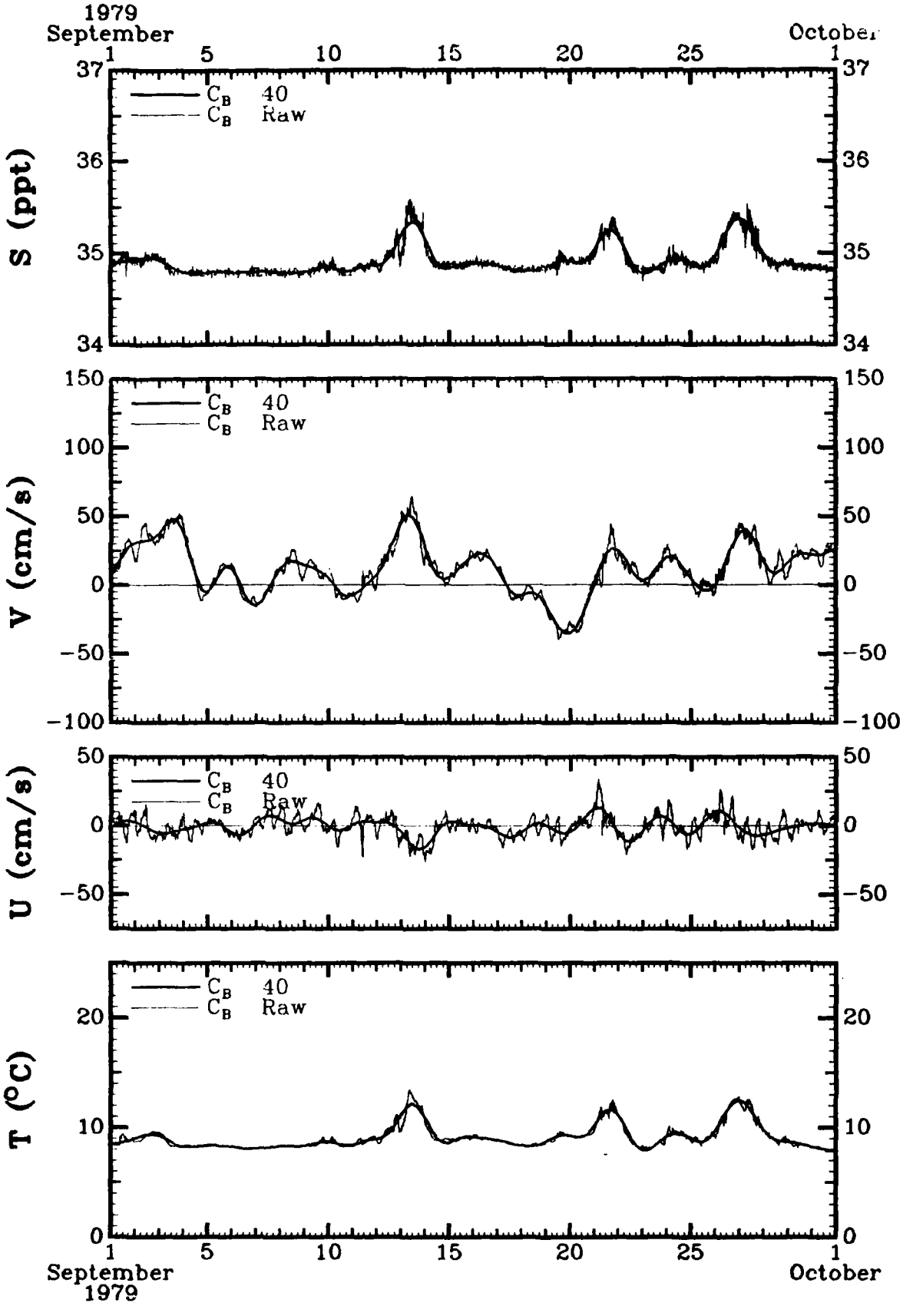

1979
August
September
1
5
10
15
20
25
30
1
S (ppt)
37
36
35
34
C_M 40
C_M Raw
V (cm/s)
150
100
50
0
−50
−100
U (cm/s)
T (°C)
20
10
0
August
1979
September
Date/Time

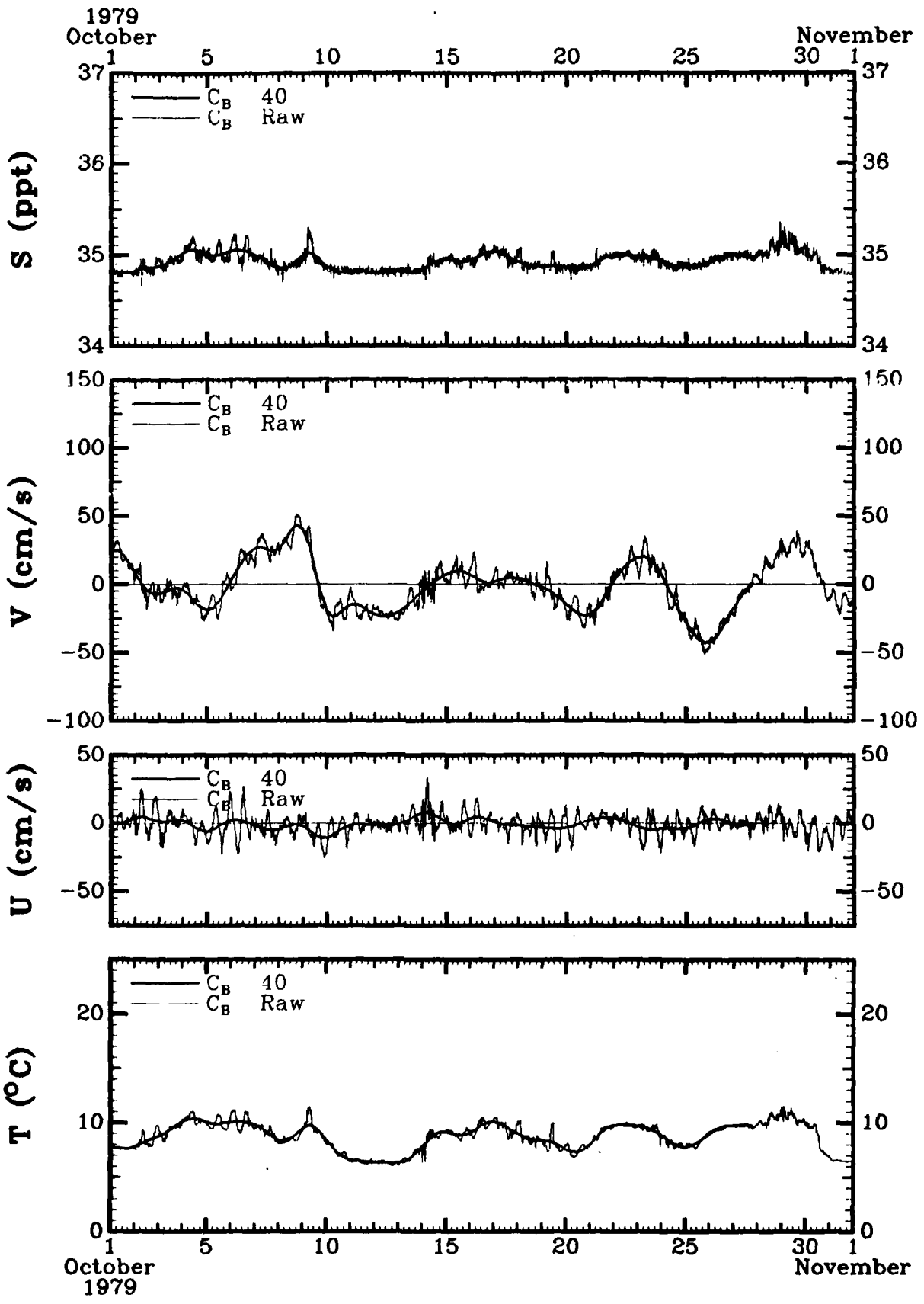

1979
September
October
1
5
10
15
20
25
1
37
36
35
34
S (ppt)
C_M 40
C_M Raw
150
100
50
0
−50
−100
V (cm/s)
U (cm/s)
20
10
T (°C)
September
1979
October
Date/Time

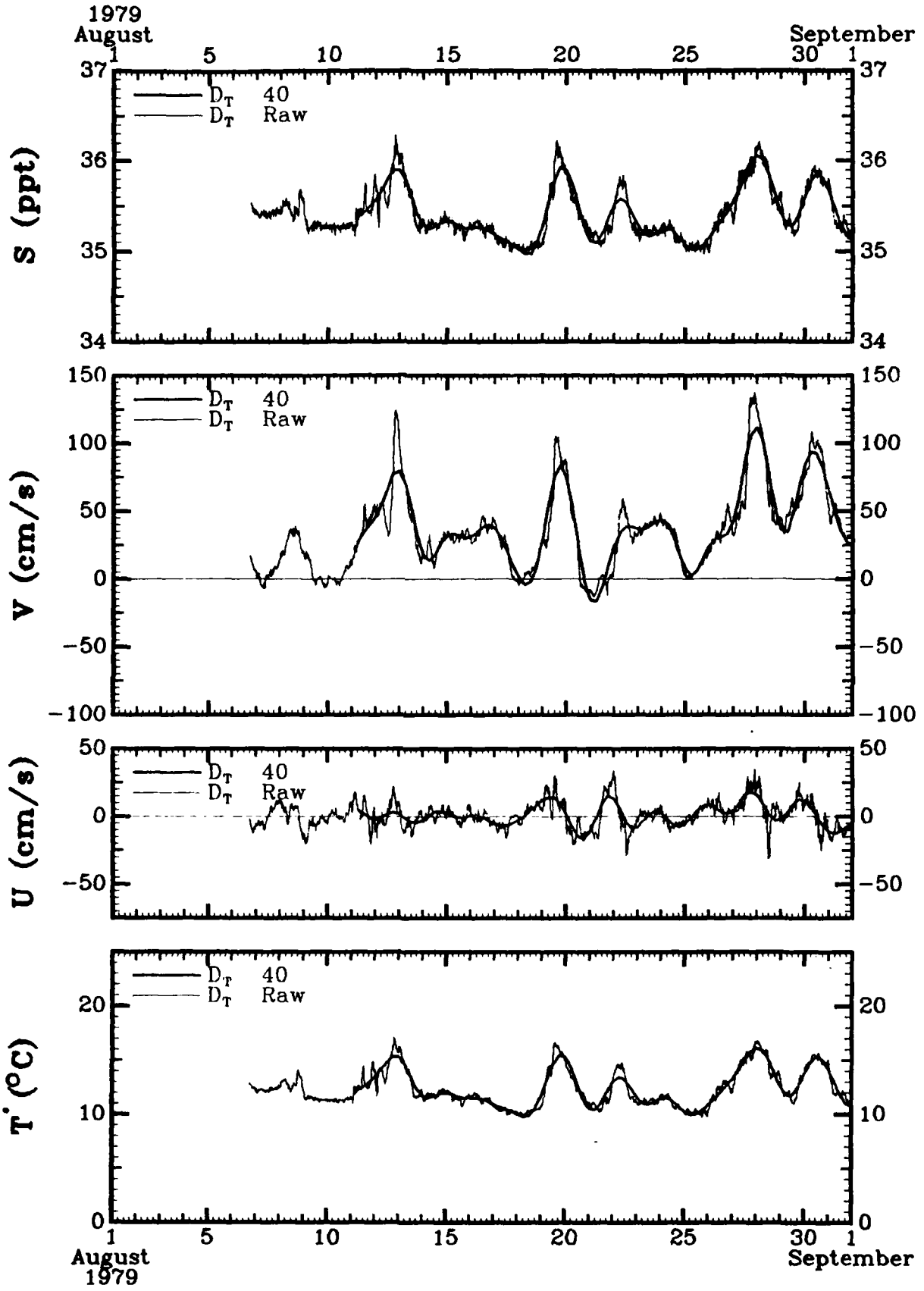

1979
October
November
1
5
10
15
20
25
30
1
S (ppt)
37
36
35
34
C_M 40
C_M Raw
V (cm/s)
150
100
50
0
−50
−100
U (cm/s)
T (°C)
20
10
0
October
1979
November
Date/Time

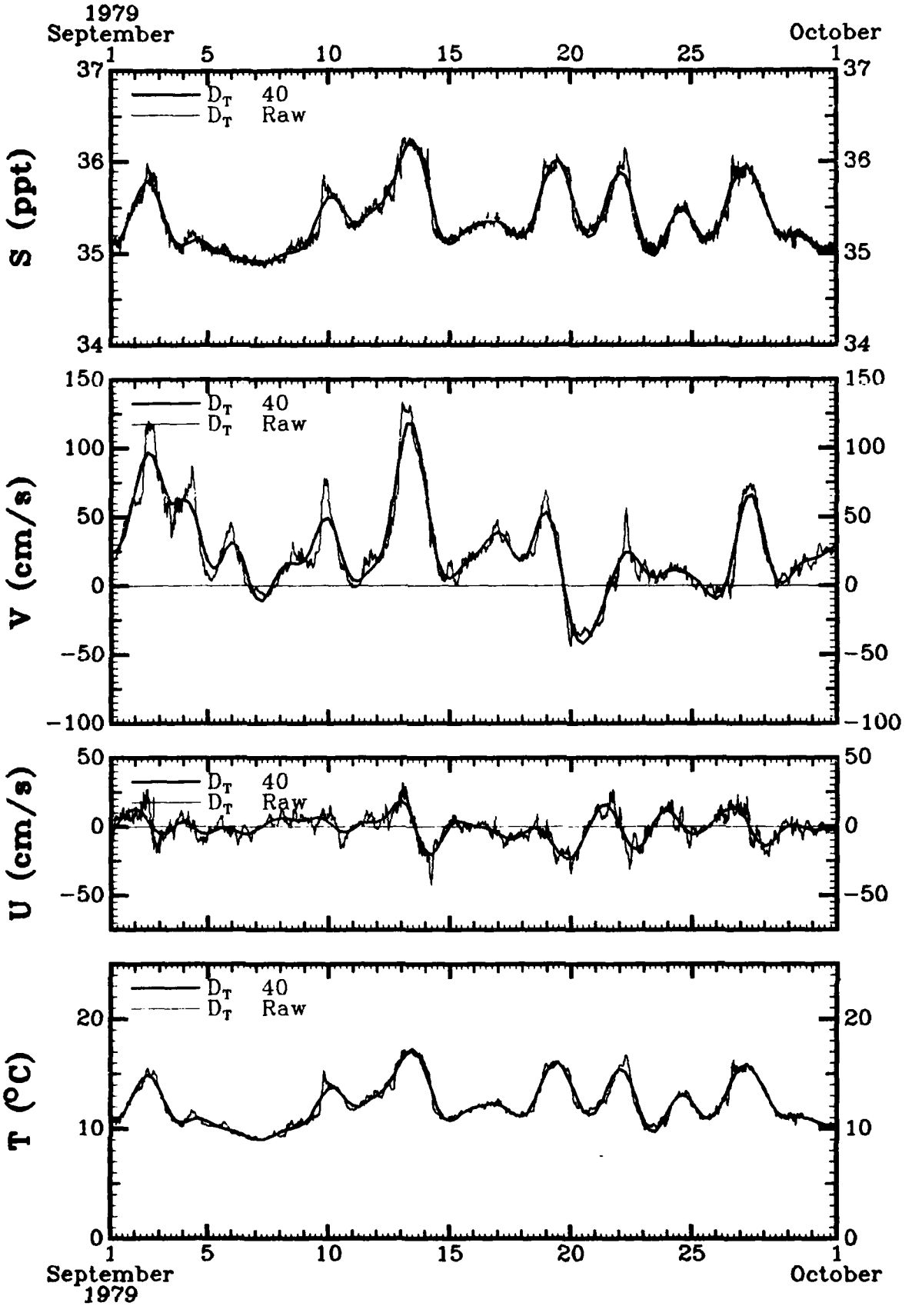

1979
November
December
1
5
10
15
20
25
1
37
36
35
34
S (ppt)
C_M 40
C_M Raw
150
100
50
0
−50
−100
V (cm/s)
U (cm/s)
20
10
0
T (°C)
C_M 10
November
1979
Date/Time

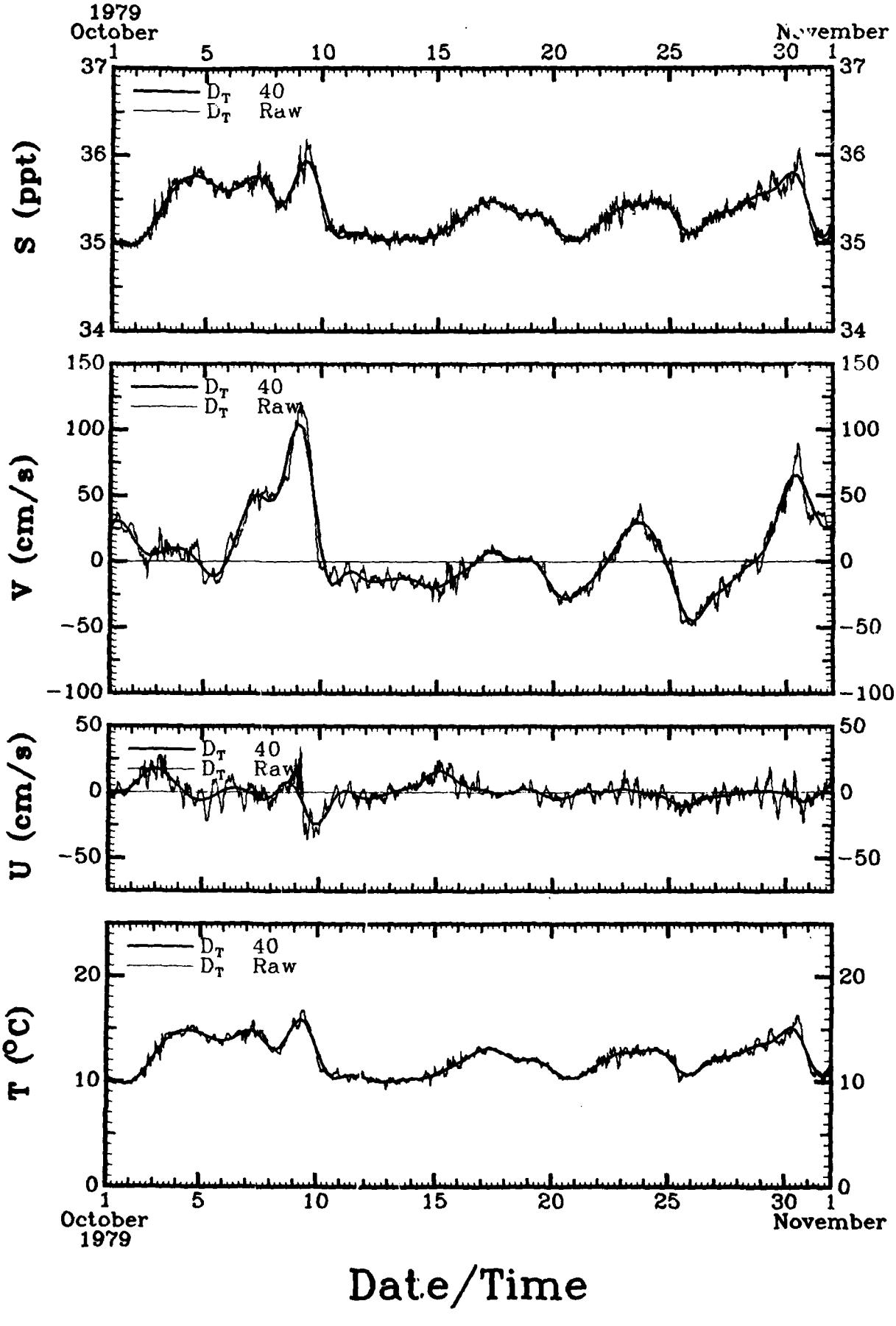

1979
August
September
1
5
10
15
20
25
30
1
S (ppt)
37
36
35
34
C_B 40
C_B Raw
V (cm/s)
150
100
50
0
−50
−100
U (cm/s)
50
0
−50
T (°C)
20
10
0
August
1979
Date/Time

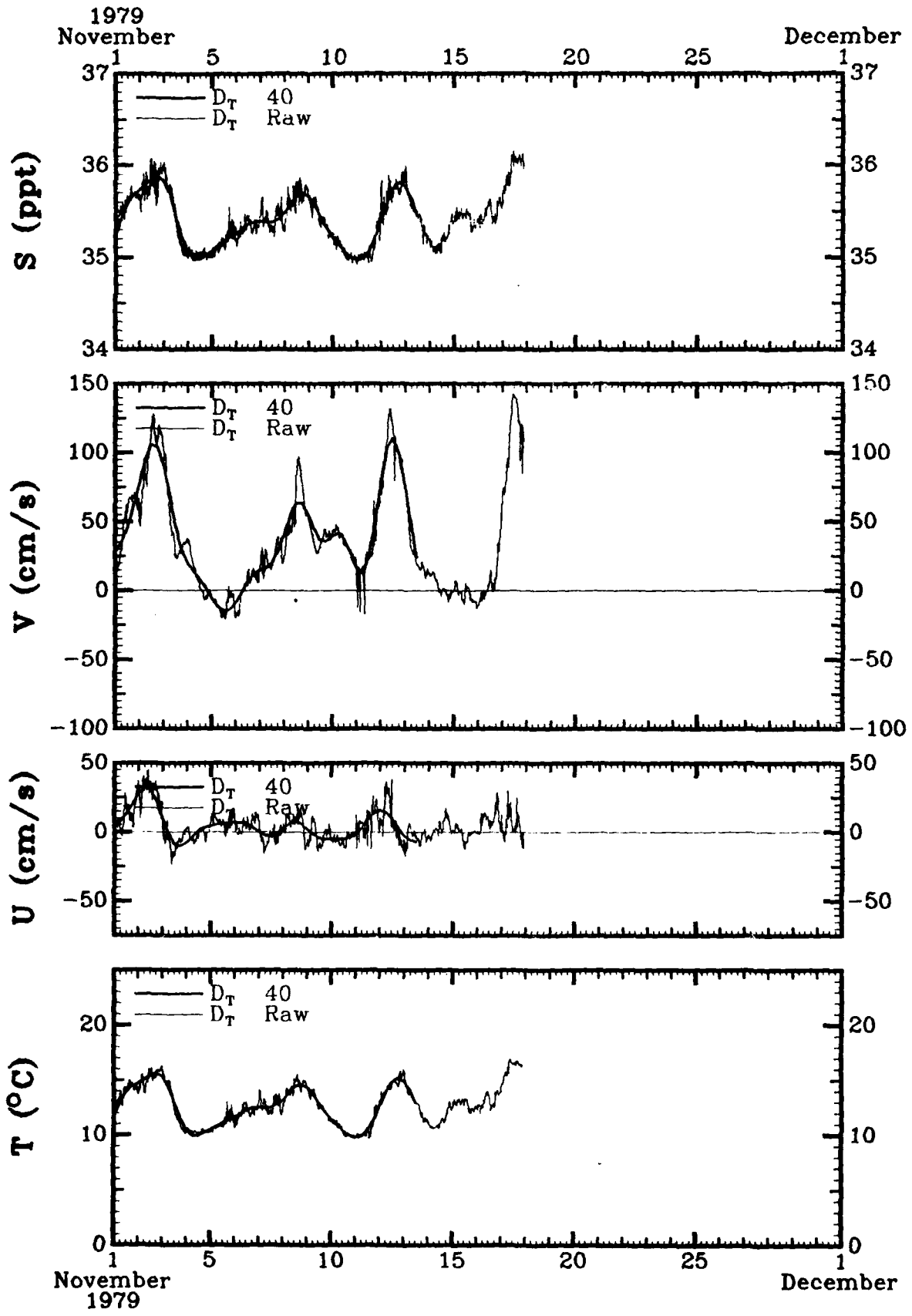

1979
September
October
1
5
10
15
20
25
1
S (ppt)
37
36
35
34
C_B 40
C_B Raw
V (cm/s)
150
100
50
0
−50
−100
U (cm/s)
T (°C)
20
10
0
September
1979
October
Date/Time


1979
October
November
1
5
10
15
20
25
30
1
S (ppt)
37
36
35
34
C_B 40
C_B Raw
V (cm/s)
150
100
50
0
−50
−100
U (cm/s)
T (°C)
20
10
0
October
1979
November
Date/Time


1979
August
September
1
5
10
15
20
25
30
1
37
36
35
34
S (ppt)
D_T 40
D_T Raw
150
100
50
0
−50
−100
V (cm/s)
U (cm/s)
20
10
T (°C)
August
1979
September
Date/Time


1979
September
October
1
5
10
15
20
25
1
37
36
35
34
S (ppt)
D_T 40
D_T Raw
150
100
50
0
−50
−100
V (cm/s)
U (cm/s)
20
10
0
T (°C)
September
1979
Date/Time

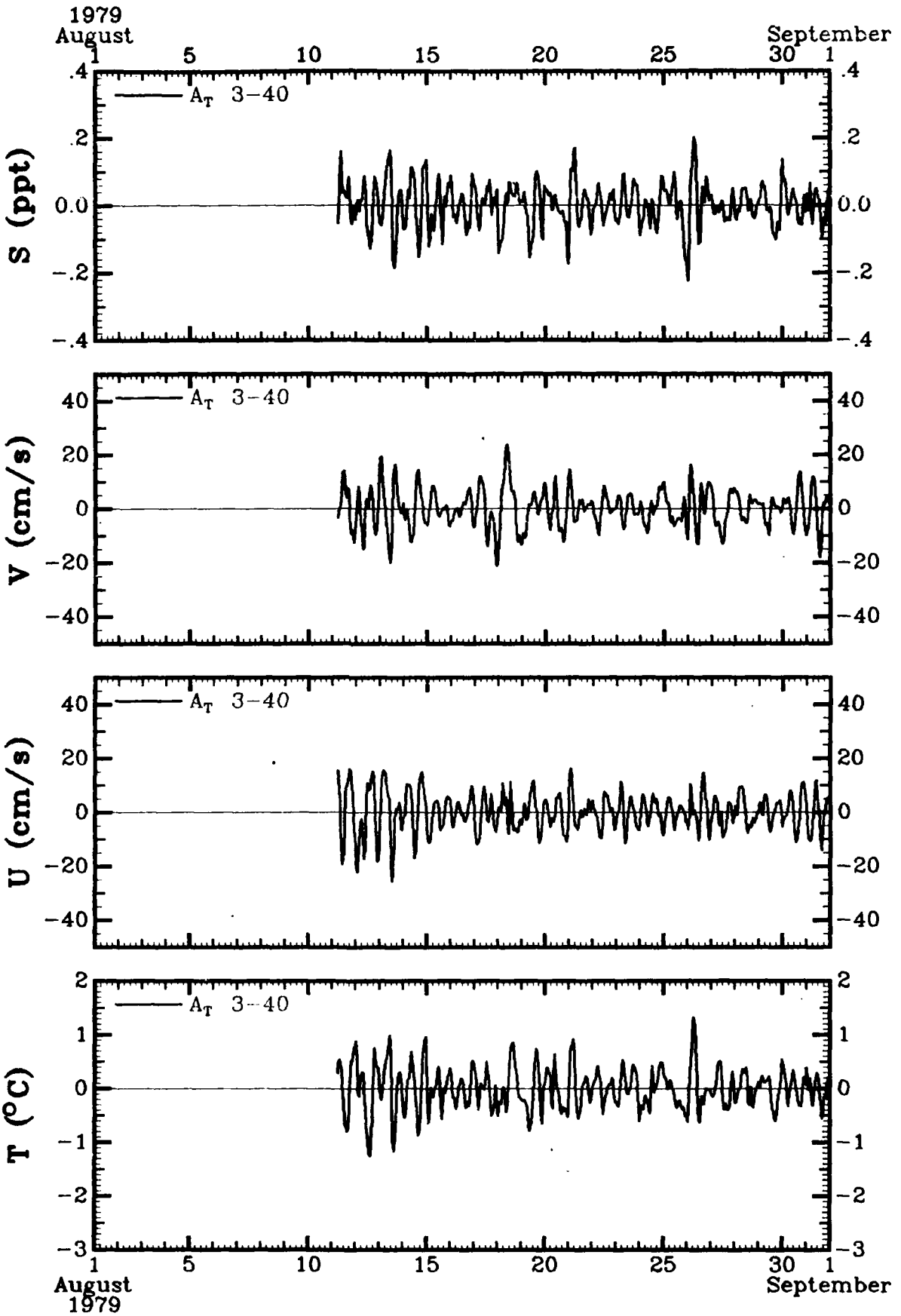

1979
October
November
1
5
10
15
20
25
30
1
37
36
35
34
S (ppt)
D_T 40
D_T Raw
150
100
50
0
−50
−100
V (cm/s)
50
0
−50
U (cm/s)
20
10
0
T (°C)
October
1979
November
Date/Time

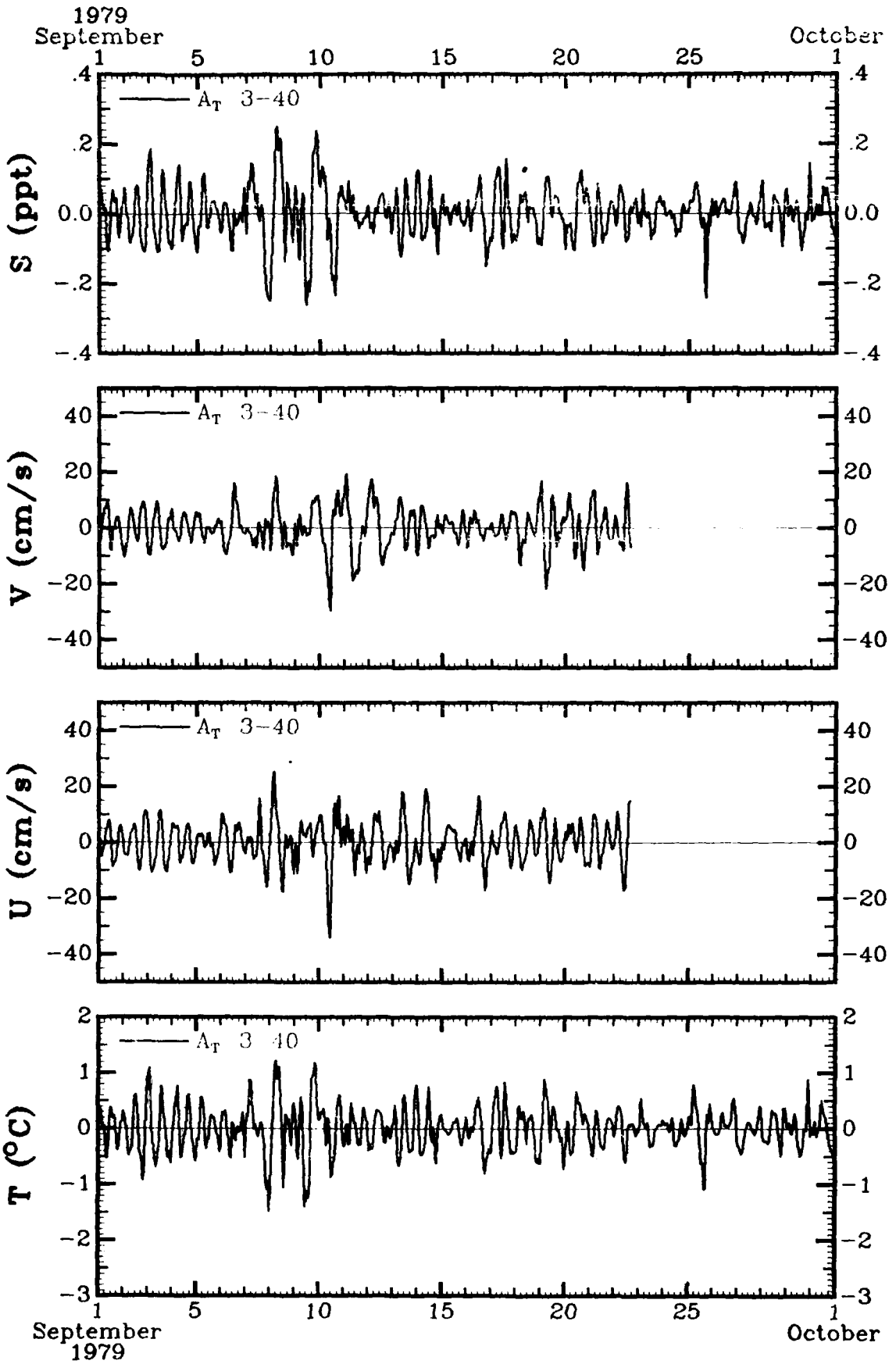

1979
November
December
1
5
10
15
20
25
1
S (ppt)
37
36
35
34
D_T 40
D_T Raw
V (cm/s)
150
100
50
0
−50
−100
U (cm/s)
50
0
−50
T (°C)
20
10
0
November
1979
December
Date/Time

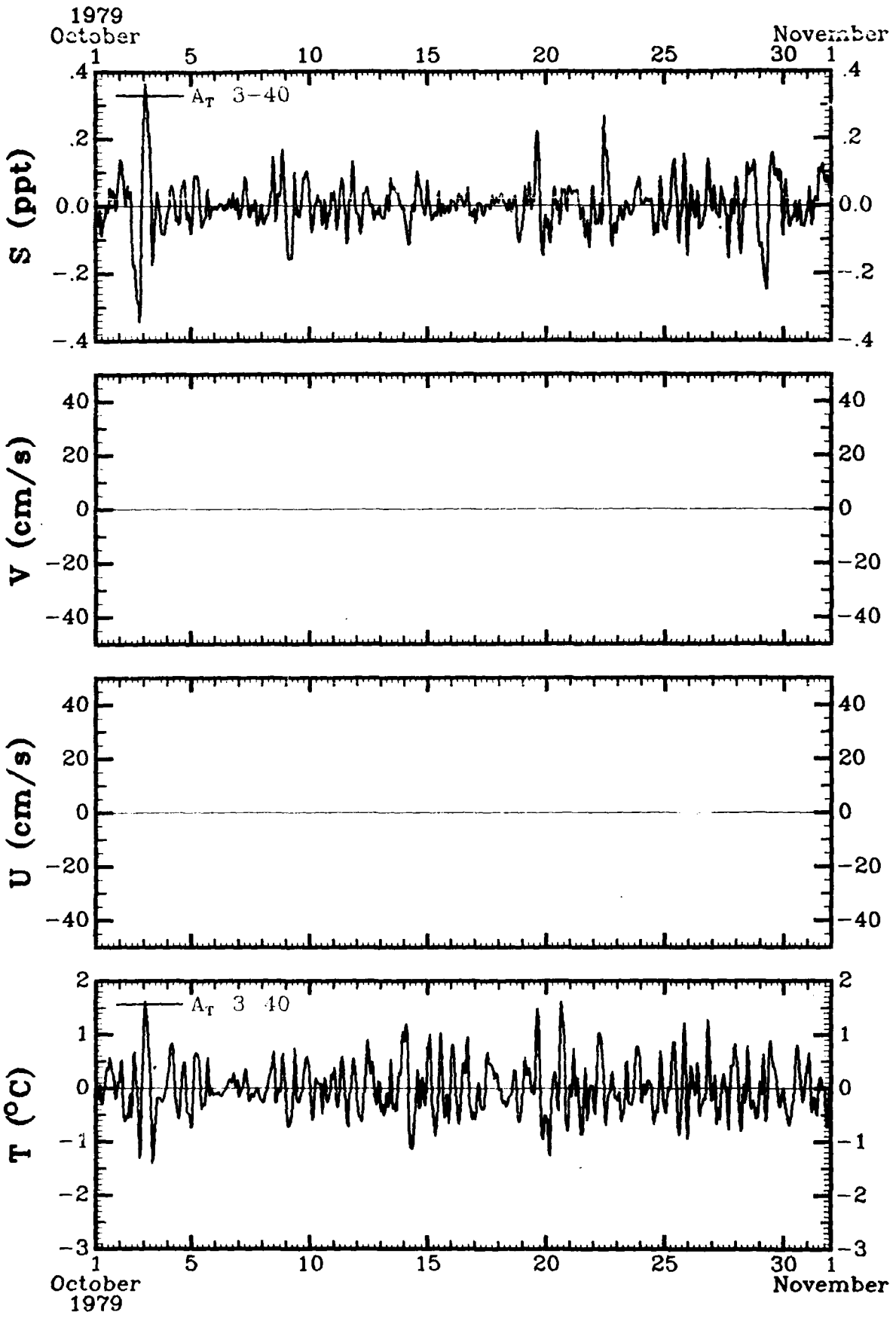
SECTION 4

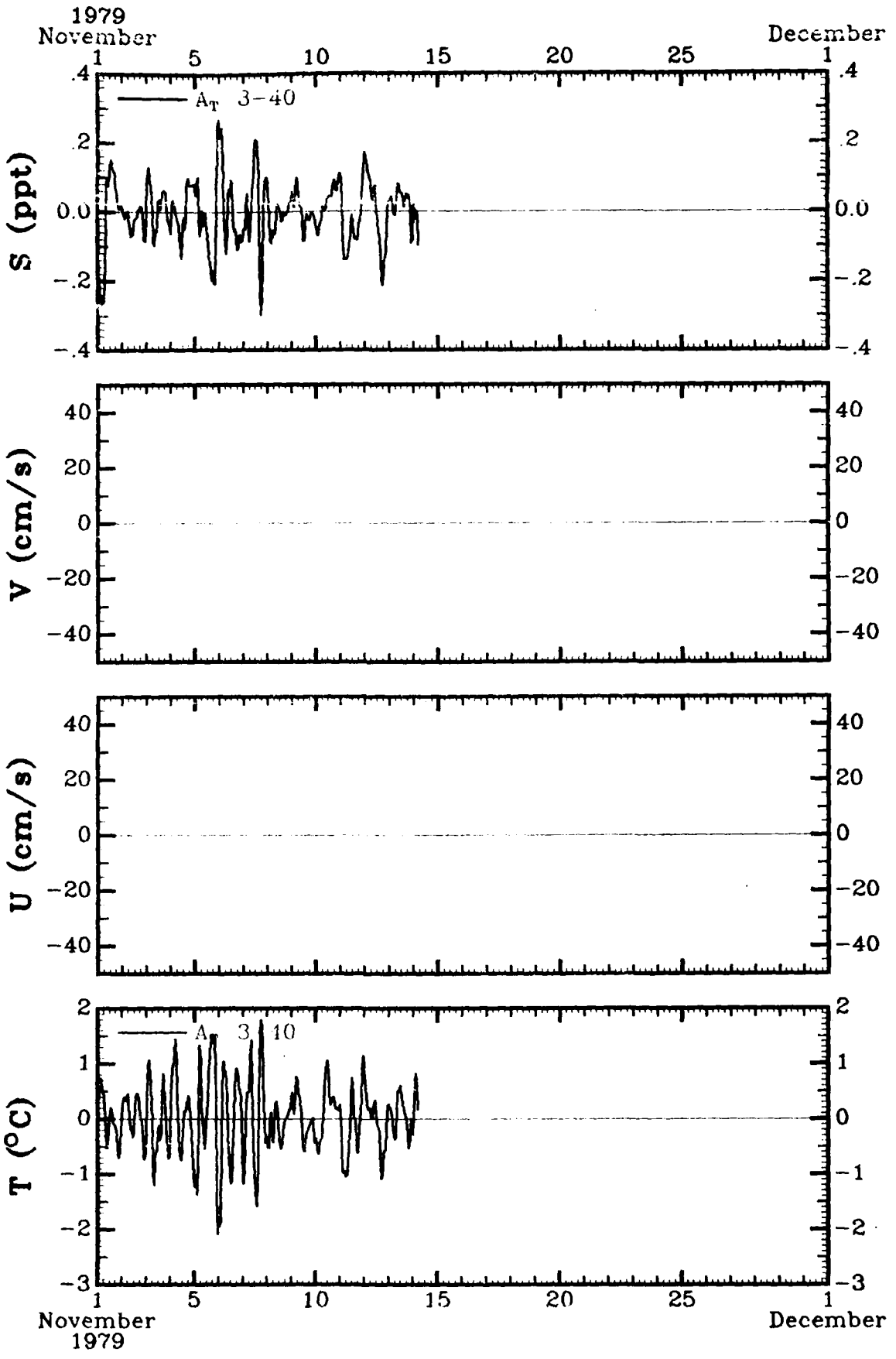
3-40 HRBP Data for Each Instrument

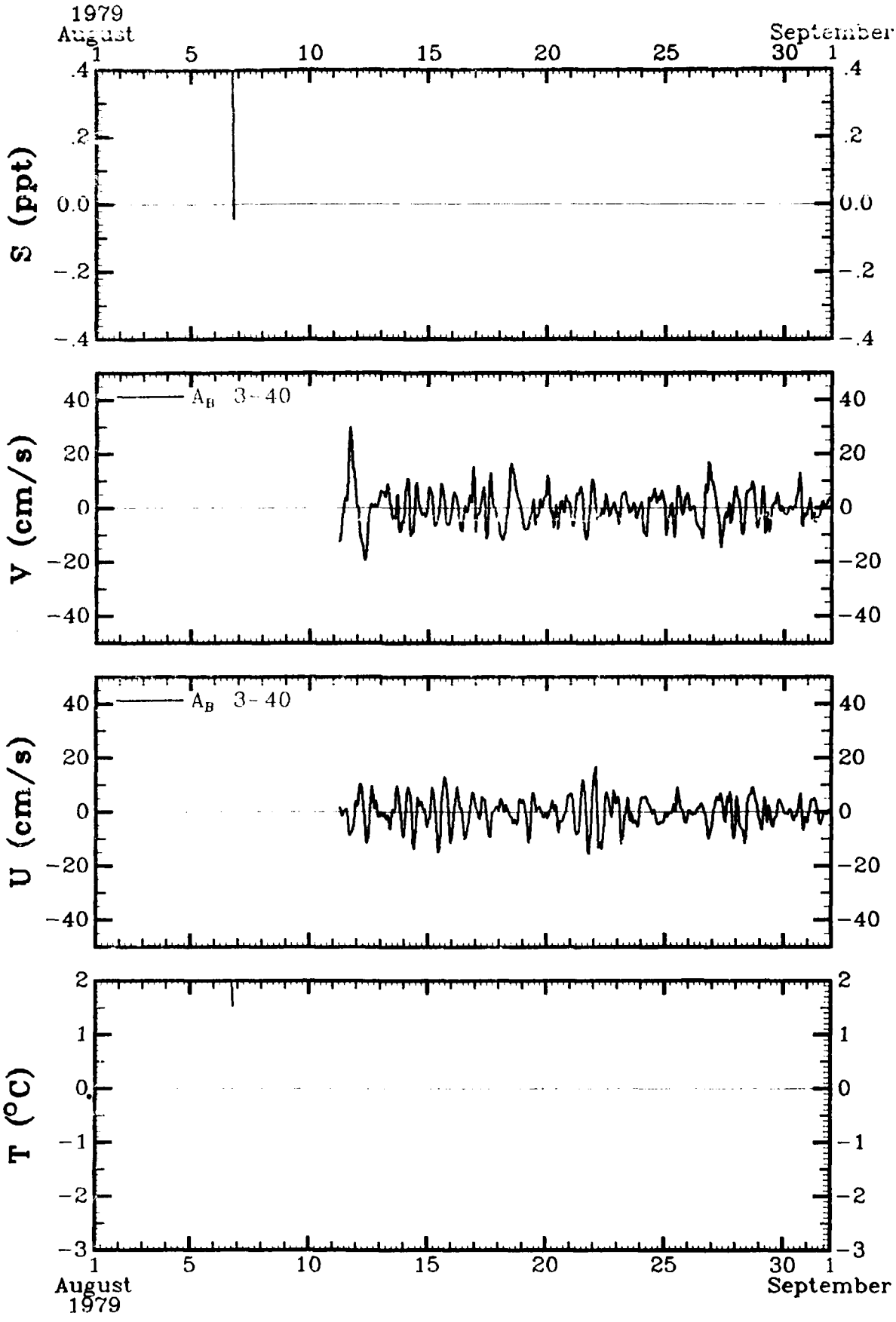
Figures 23 through 30 show the 3-40 HRBP current meter data separately by month for each instrument. The scale factors for similar data are not the same for all instruments in this section. Note that the bandpass operation removes the mean value.

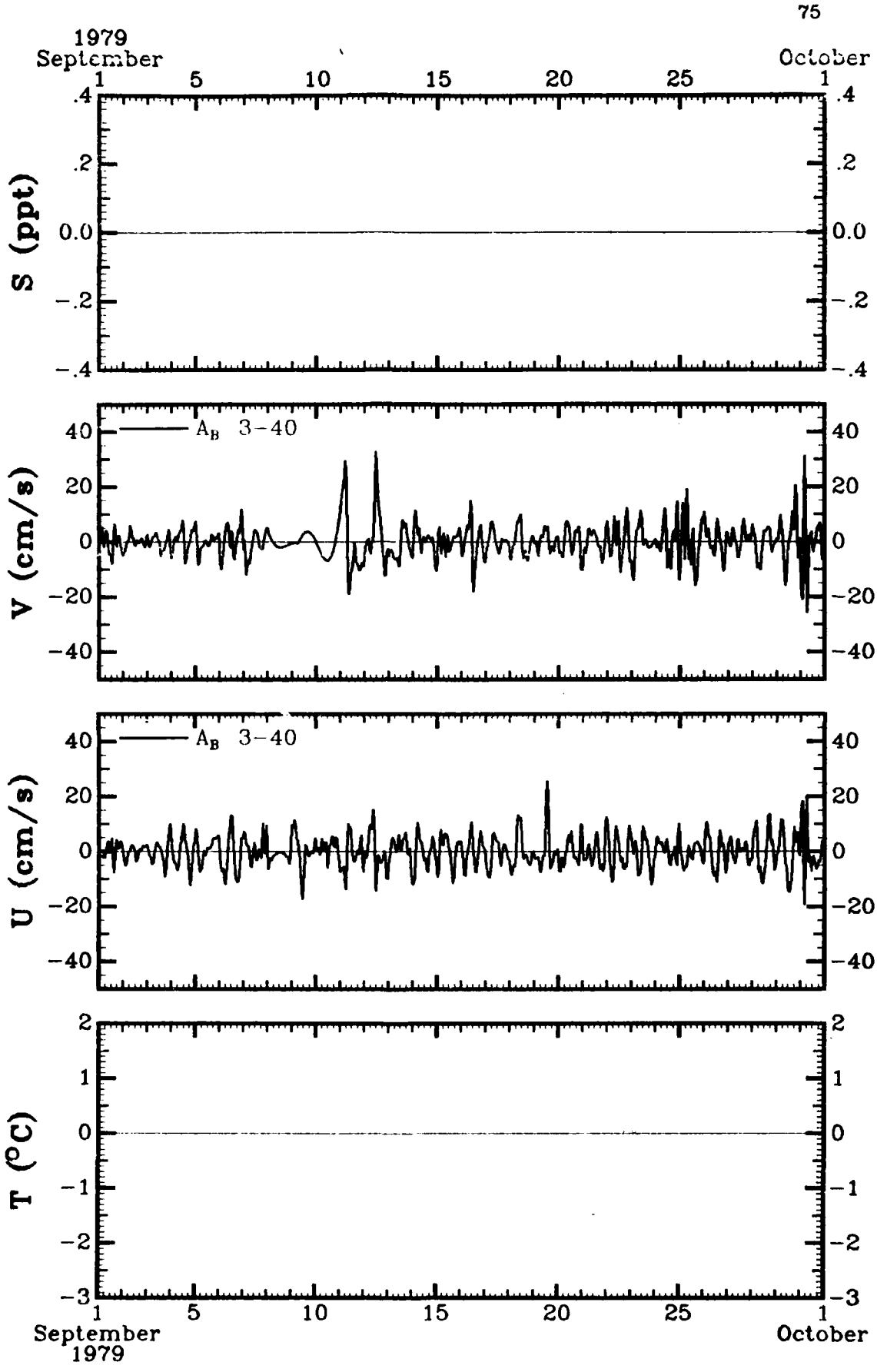

1979
August
September
1
5
10
15
20
25
30
1
S (ppt)
V (cm/s)
U (cm/s)
T (°C)
A_T 3–40
.4
.2
0.0
−.2
−.4
40
20
0
−20
−40
2
1
0
−1
−2
−3
August
1979
September
Date/Time

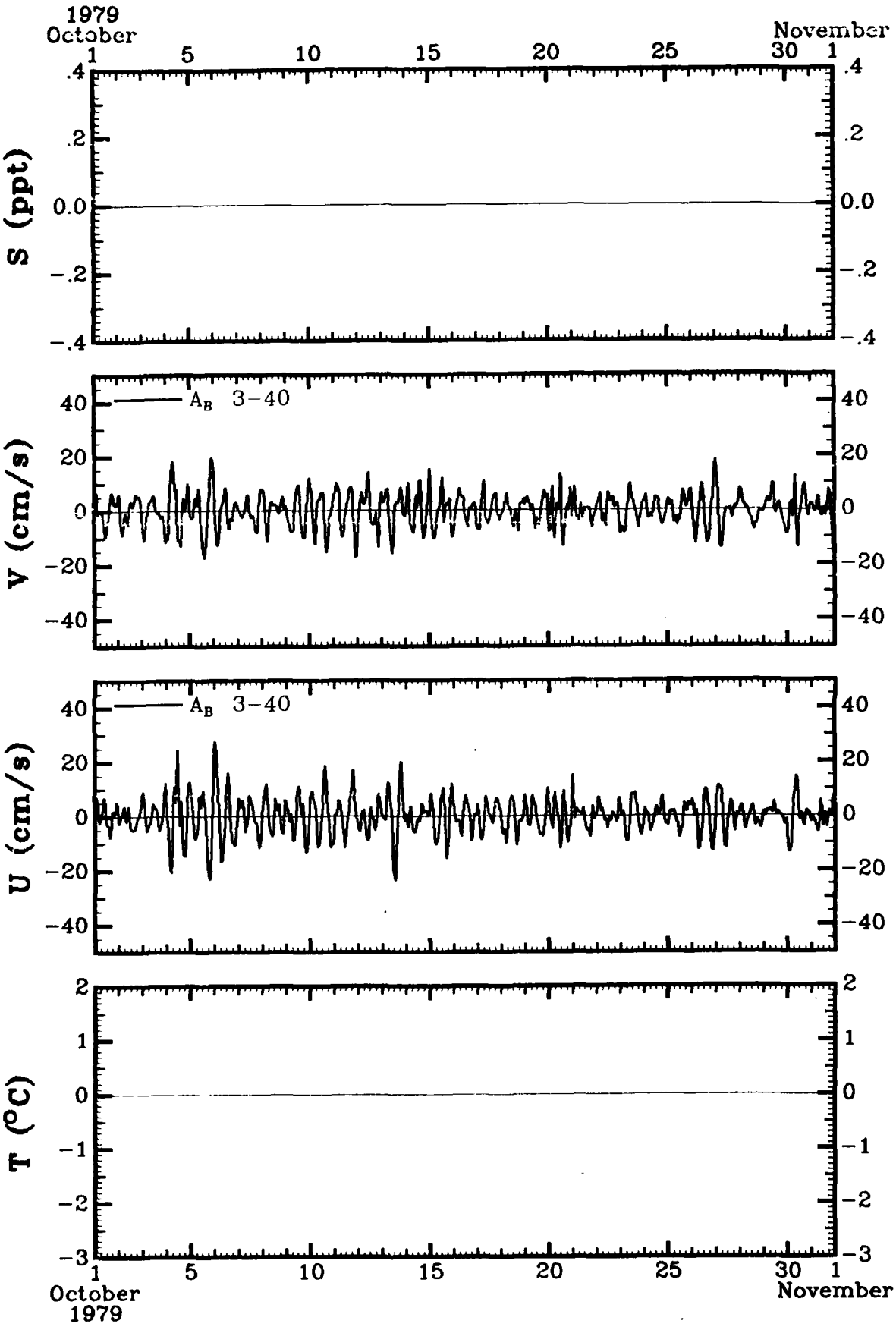

1979
September
October
1
5
10
15
20
25
1
A_T 3–40
S (ppt)
.4
.2
0.0
–.2
–.4
V (cm/s)
40
20
0
–20
–40
U (cm/s)
T (°C)
2
1
0
–1
–2
–3
September
1979
October
Date/Time

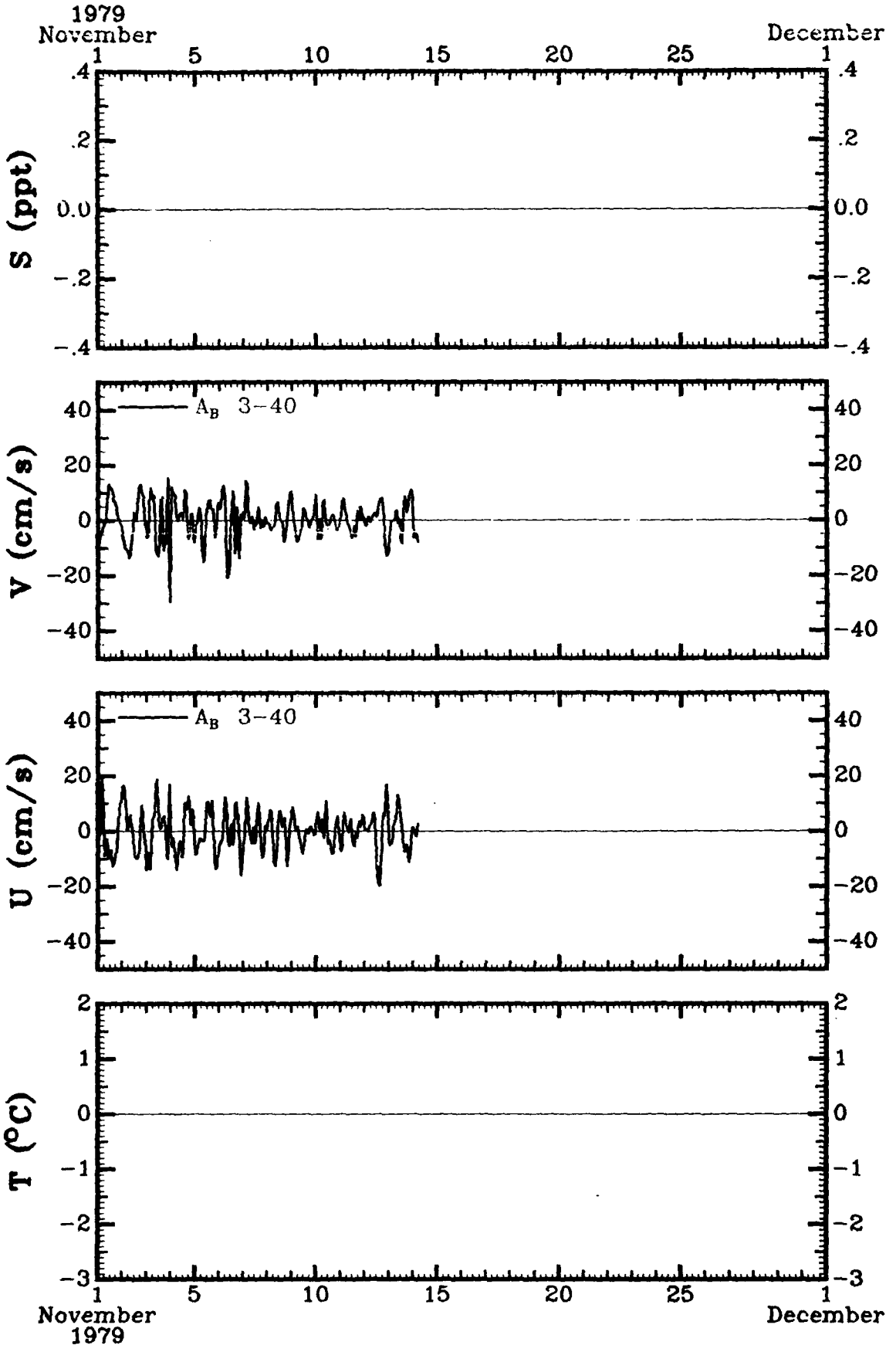

1979
October
November
1 5 10 15 20 25 30 1
A_T 3-40
S (ppt)
.4 .2 0.0 -.2 -.4
V (cm/s)
40 20 0 -20 -40
U (cm/s)
40 20 0 -20 -40
A_T 3 40
T (°C)
2 1 0 -1 -2 -3
1 5 10 15 20 25 30 1
October
1979
November
Date/Time

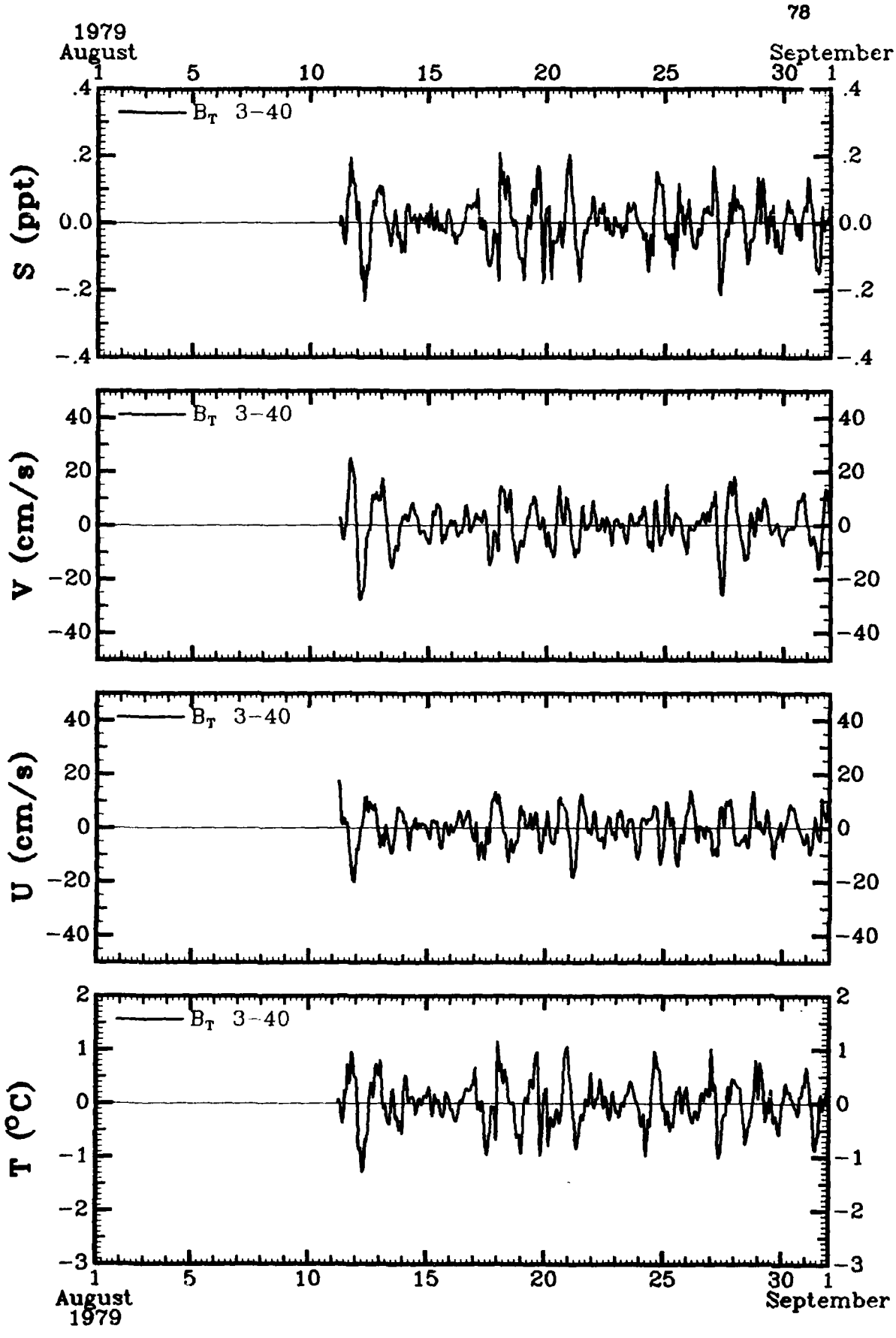

1979
November
December
1
5
10
15
20
25
1
A_T 3-40
S (ppt)
.4
.2
0.0
-.2
-.4
V (cm/s)
40
20
0
-20
-40
U (cm/s)
40
20
0
-20
-40
A_T 3 10
T (°C)
2
1
0
-1
-2
-3
November
1979
December
Date/Time

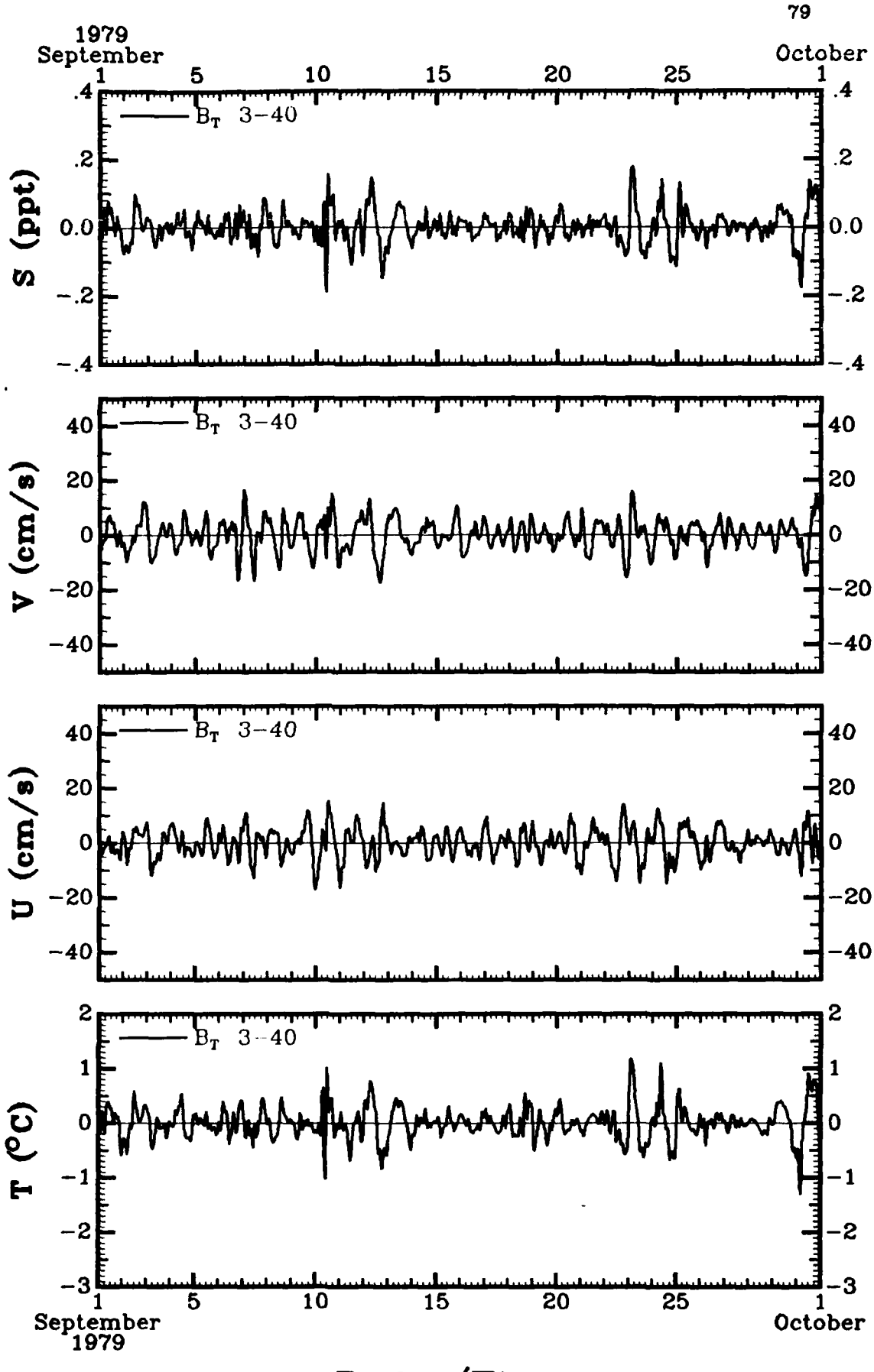

1979
August
September
1
5
10
15
20
25
30
1
S (ppt)
.4
.2
0.0
−.2
−.4
V (cm/s)
A_B 3-40
40
20
0
−20
−40
U (cm/s)
A_B 3-40
T (°C)
2
1
0
−1
−2
−3
August
1979
September
Date/Time

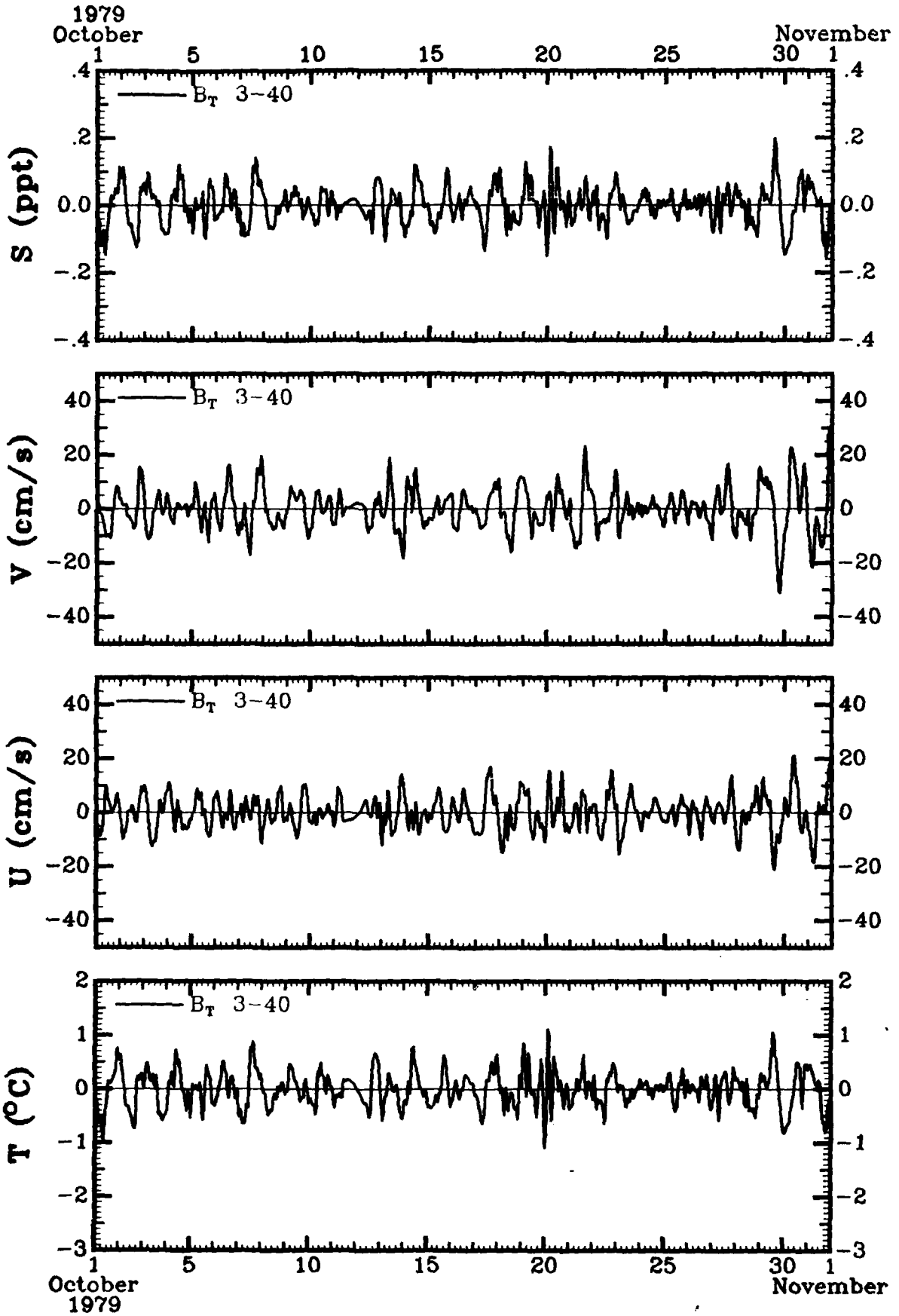

1979
September
October
1
5
10
15
20
25
1
S (ppt)
.4
.2
0.0
−.2
−.4
V (cm/s)
A_B 3–40
40
20
0
−20
−40
U (cm/s)
A_B 3–40
T (°C)
2
1
0
−1
−2
−3
September
1979
October
Date/Time

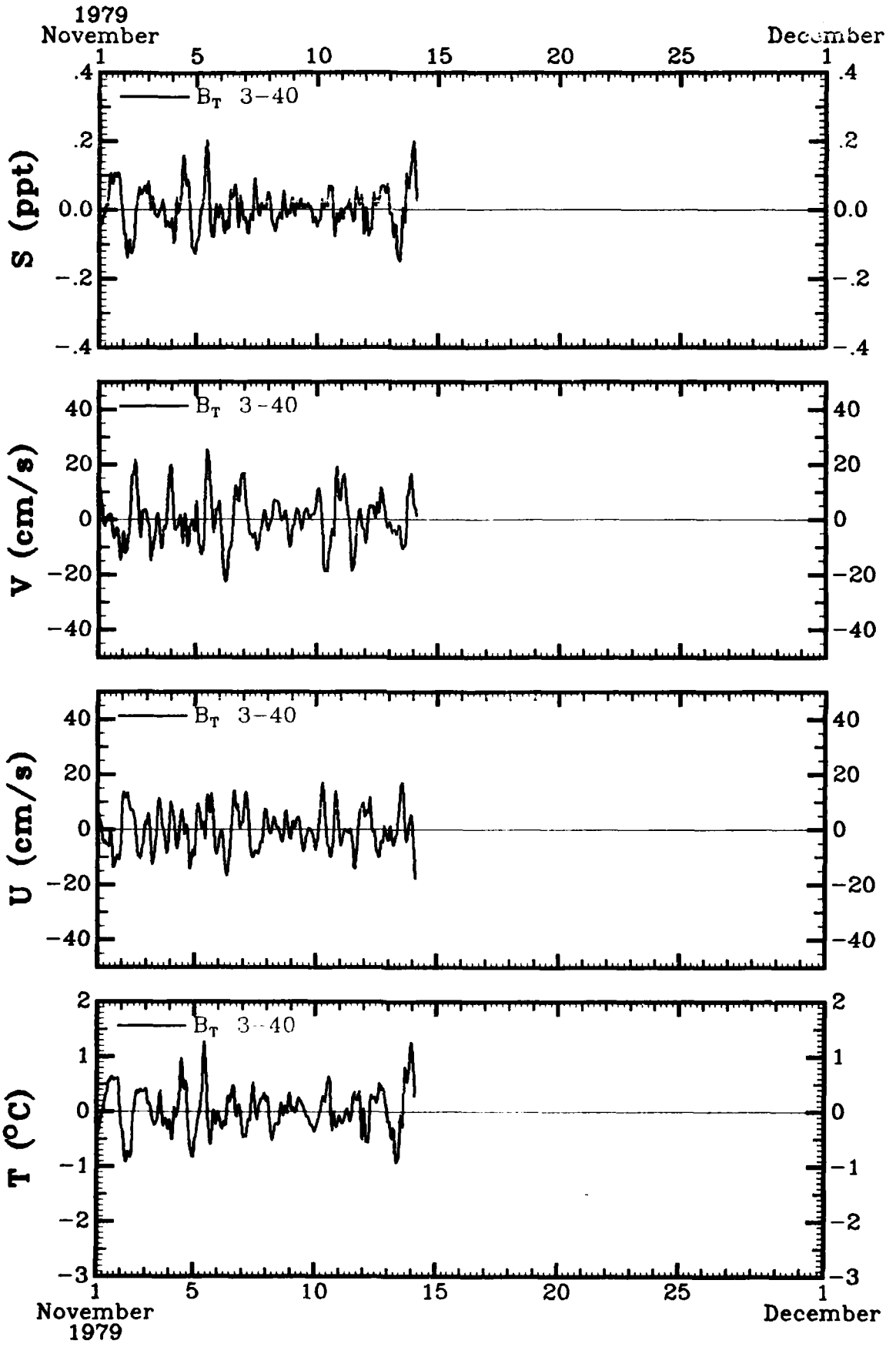

1979
October
November
1
5
10
15
20
25
30
1
S (ppt)
.4
.2
0.0
-.2
-.4
V (cm/s)
A_B 3-40
40
20
0
-20
-40
U (cm/s)
A_B 3-40
40
20
0
-20
-40
T (°C)
2
1
0
-1
-2
-3
1
October
1979
Date/Time

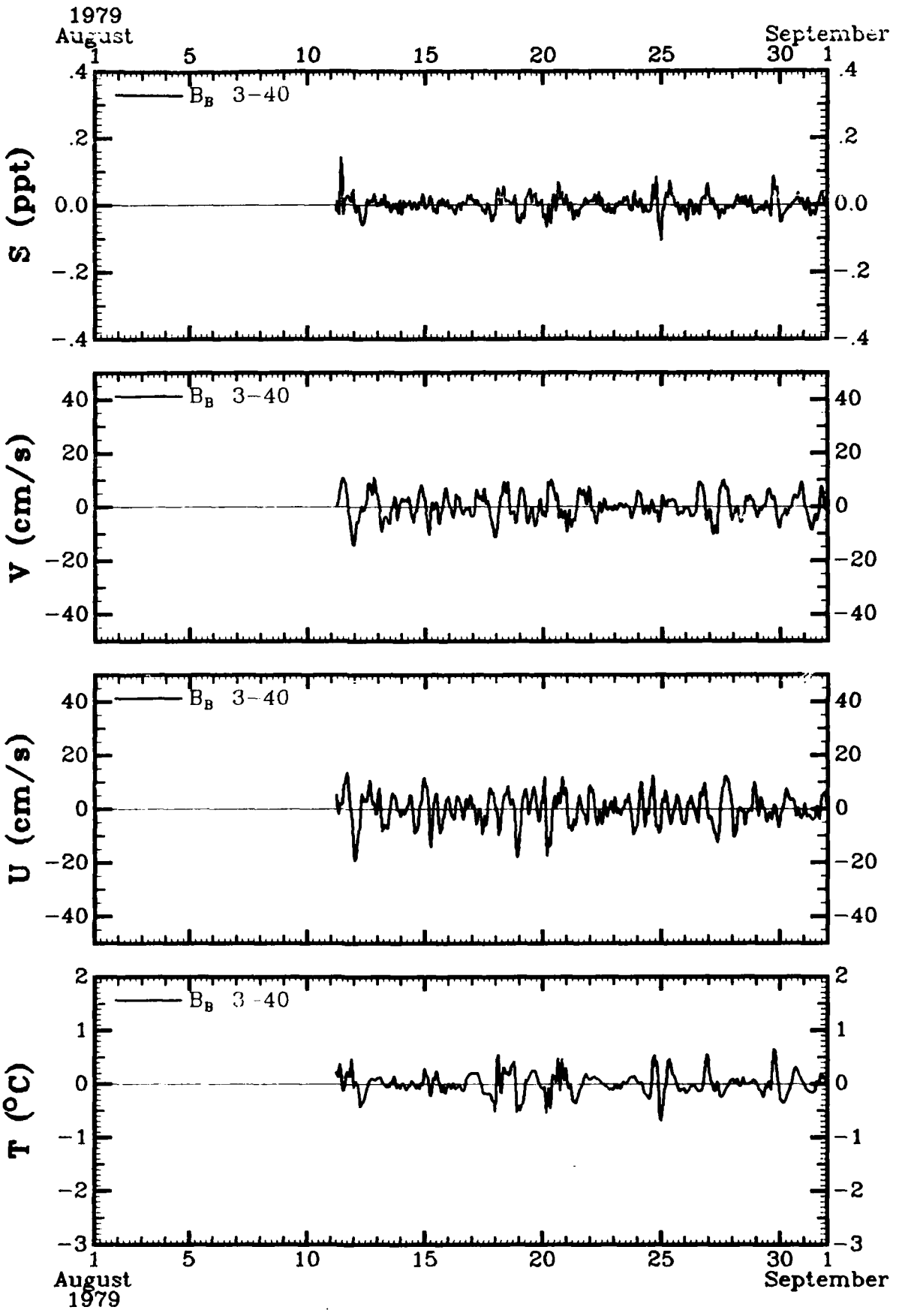

1979
November
December
1
5
10
15
20
25
1
S (ppt)
.4
.2
0.0
-.2
-.4
V (cm/s)
A_B 3-40
40
20
0
-20
-40
U (cm/s)
A_B 3-40
40
20
0
-20
-40
T (°C)
2
1
0
-1
-2
-3
1
5
10
15
20
25
1
November
1979
December
Date/Time

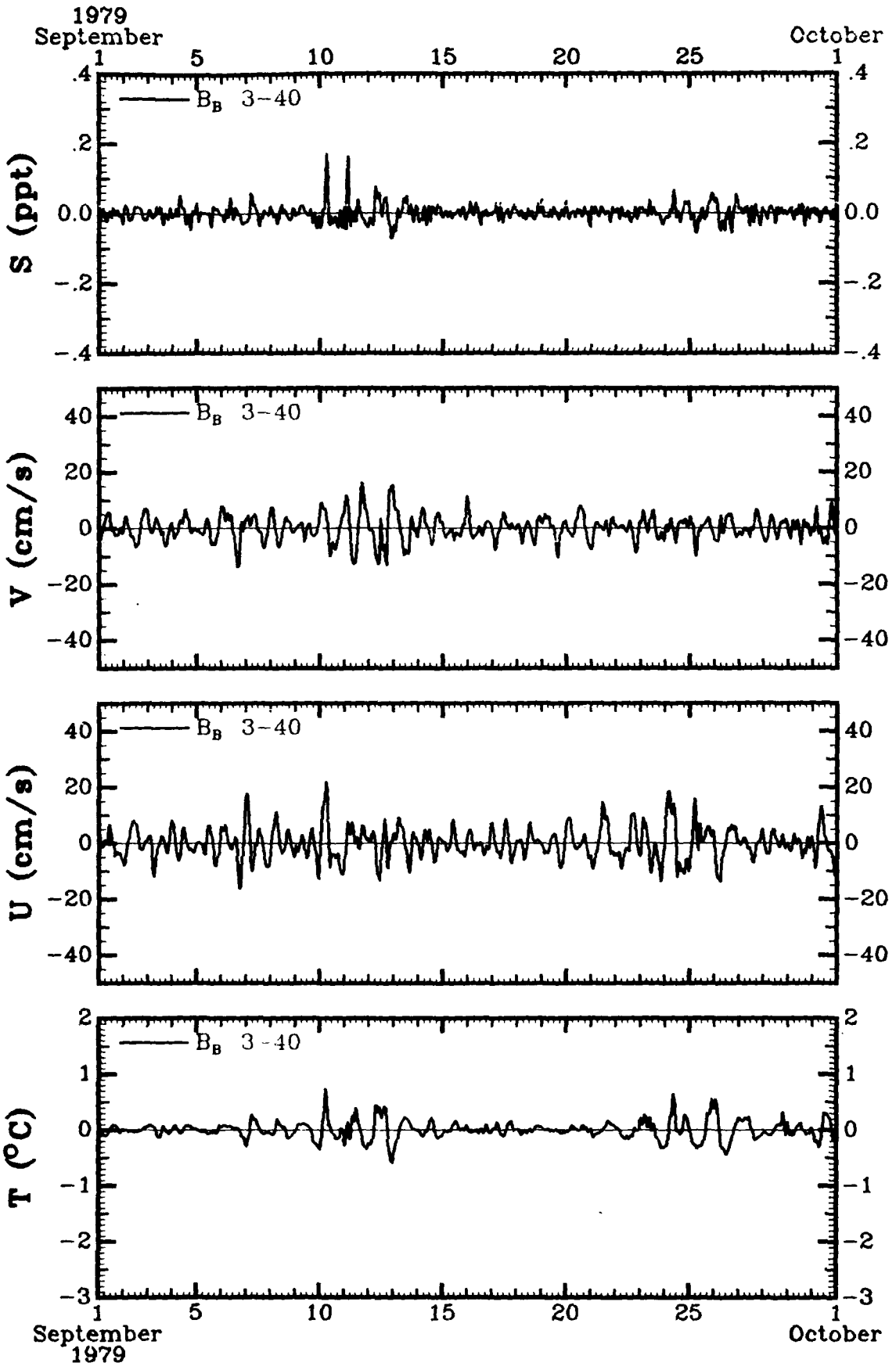

1979
August
September
1 5 10 15 20 25 30 1
B_T 3–40
S (ppt)
.4 .2 0.0 −.2 −.4
V (cm/s)
40 20 0 −20 −40
U (cm/s)
40 20 0 −20 −40
T (°C)
2 1 0 −1 −2 −3
August
1979
September
Date/Time

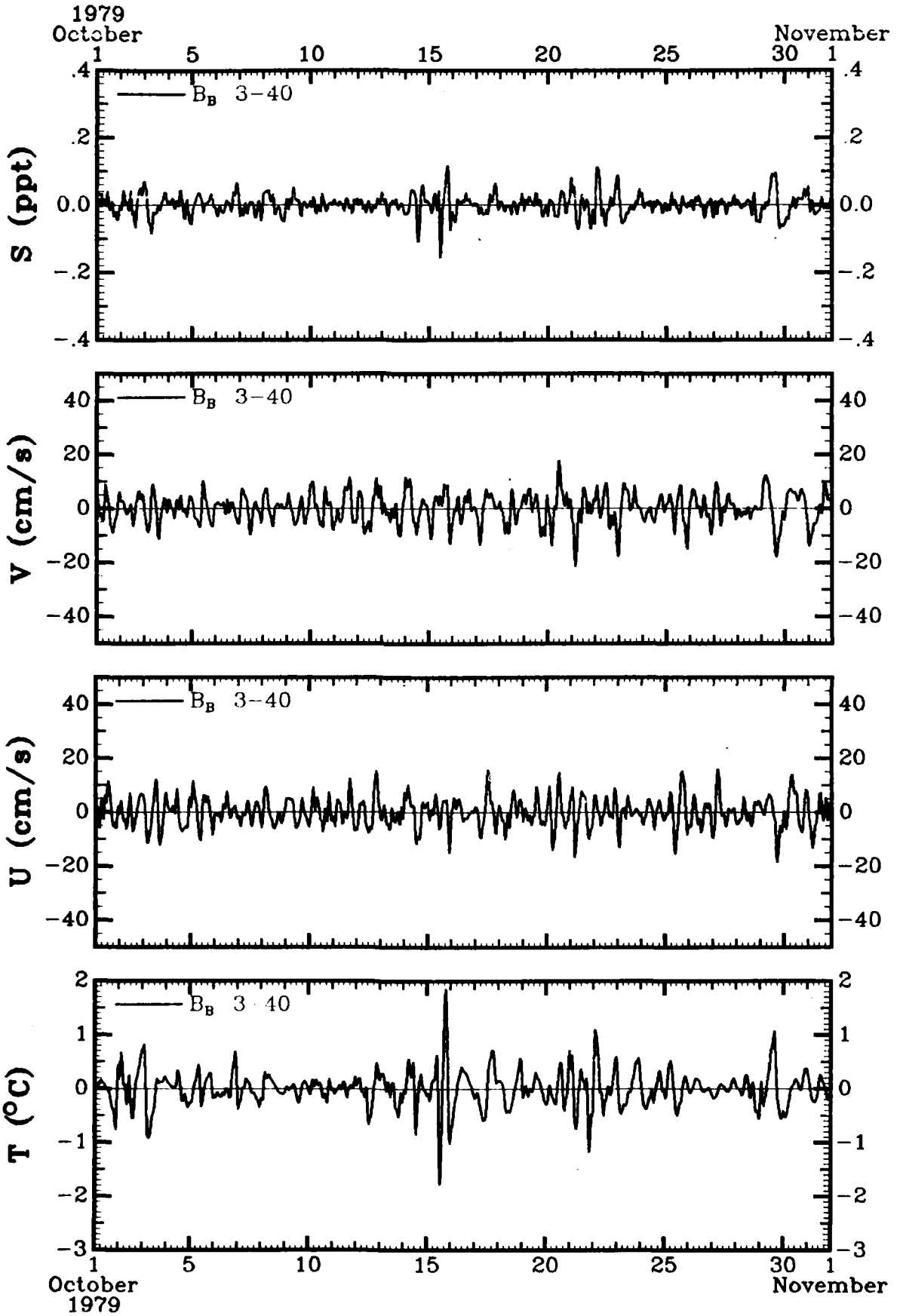

1979
September
October
1
5
10
15
20
25
1
S (ppt)
V (cm/s)
U (cm/s)
T (°C)
B_T 3–40
.4
.2
0.0
-.2
-.4
40
20
0
-20
-40
2
1
0
-1
-2
-3
September
1979
October
Date/Time

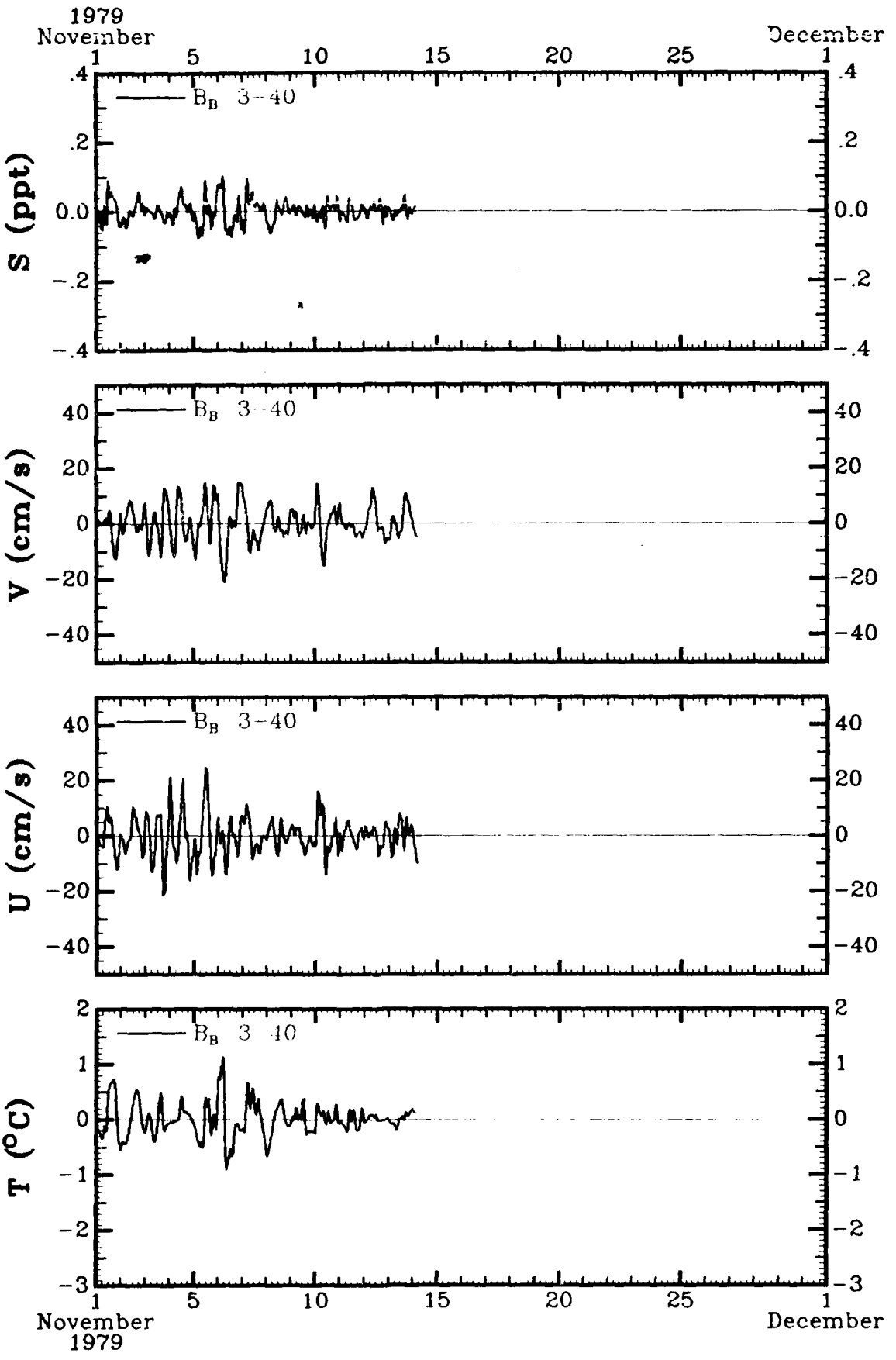

1979
October
November
1
5
10
15
20
25
30
1
S (ppt)
V (cm/s)
U (cm/s)
T (°C)
B_T 3–40
.4
.2
0.0
−.2
−.4
40
20
0
−20
−40
2
1
0
−1
−2
−3
October
1979
November
Date/Time


1979
November
December
1
5
10
15
20
25
1
B_T 3-40
S (ppt)
.4
.2
0.0
-.2
-.4
V (cm/s)
40
20
0
-20
-40
U (cm/s)
T (°C)
2
1
0
-1
-2
-3
November
1979
December
Date/Time

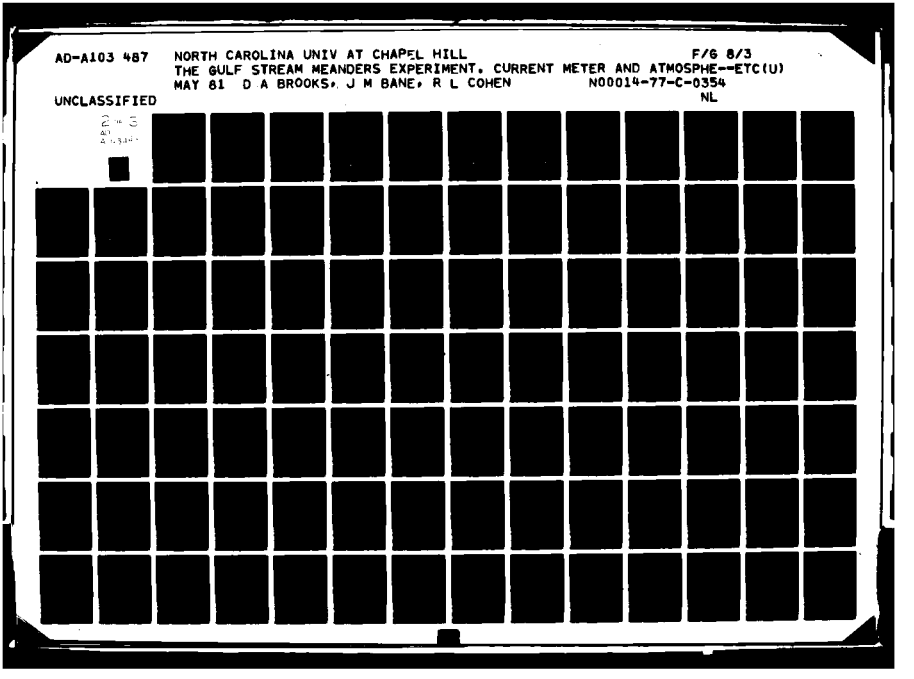

1979
August
September
1
5
10
15
20
25
30
1
B_B 3-40
S (ppt)
V (cm/s)
U (cm/s)
T (°C)
August
1979
September
Date/Time

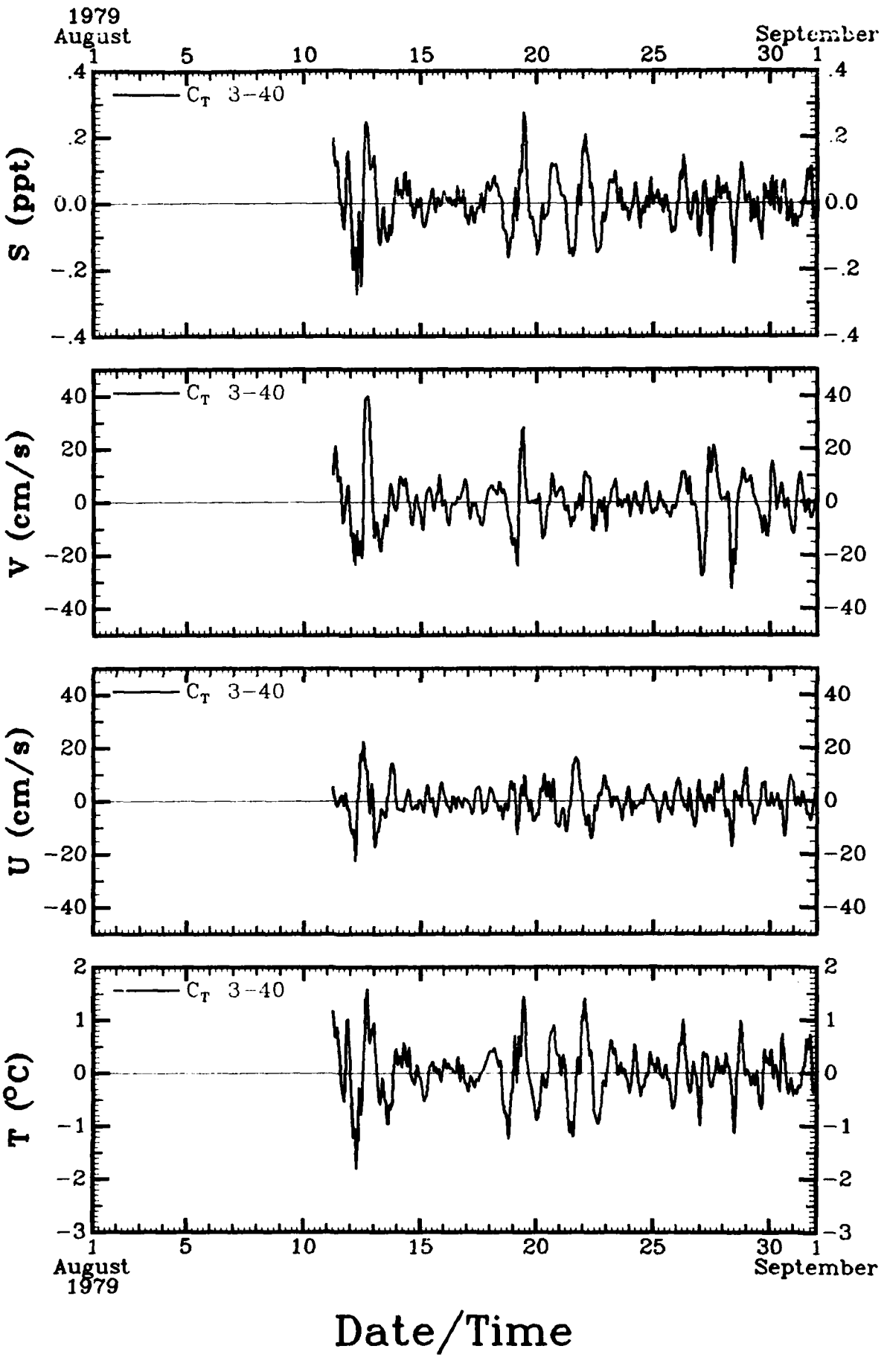

1979
September
October
1
5
10
15
20
25
1
B_B 3-40
S (ppt)
.4
.2
0.0
-.2
-.4
V (cm/s)
40
20
0
-20
-40
U (cm/s)
T (°C)
2
1
0
-1
-2
-3
September
1979
Date/Time

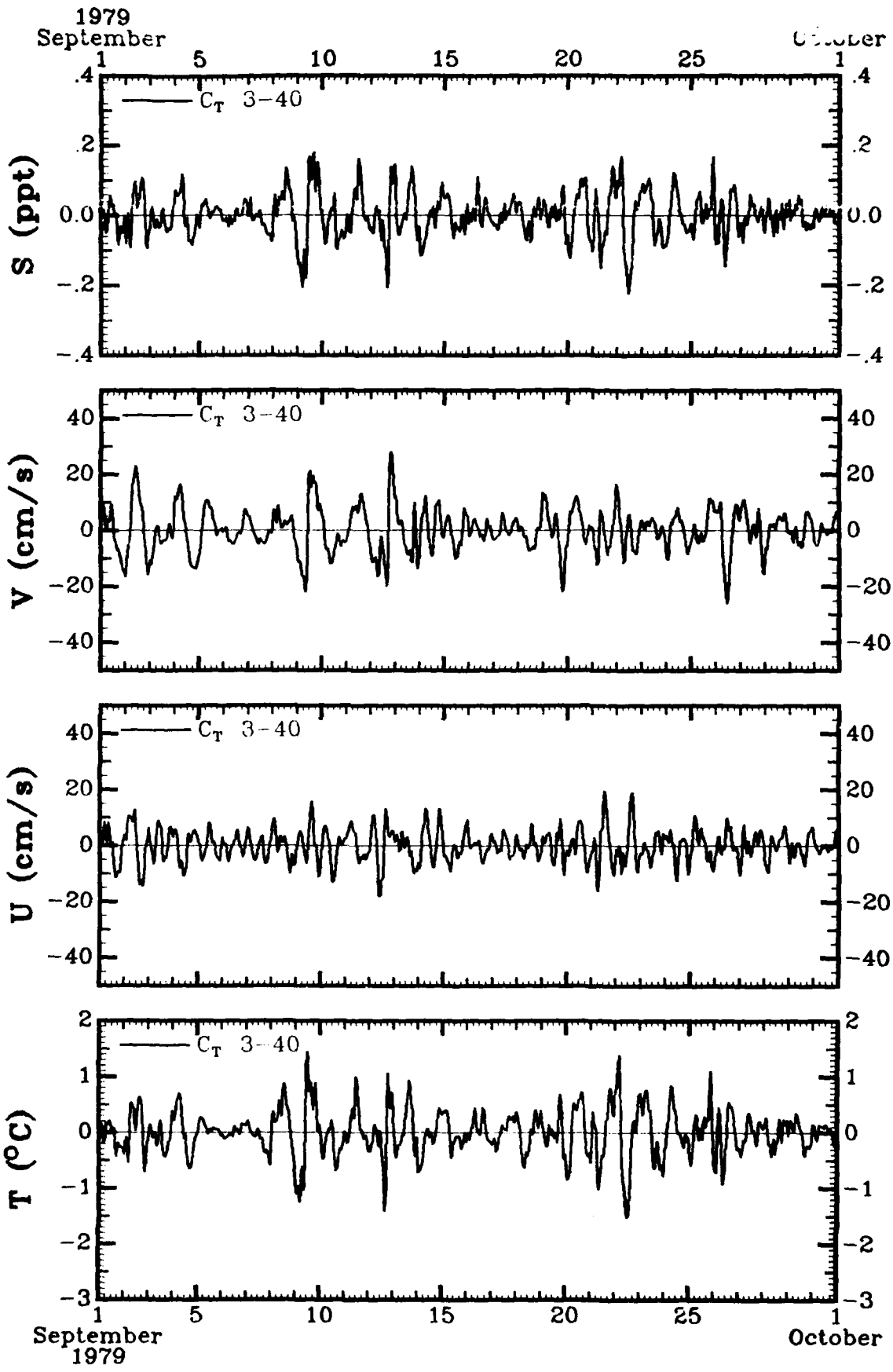

1979
October
November
1
5
10
15
20
25
30
1
S (ppt)
V (cm/s)
U (cm/s)
T (°C)
B_B 3–40
Date/Time

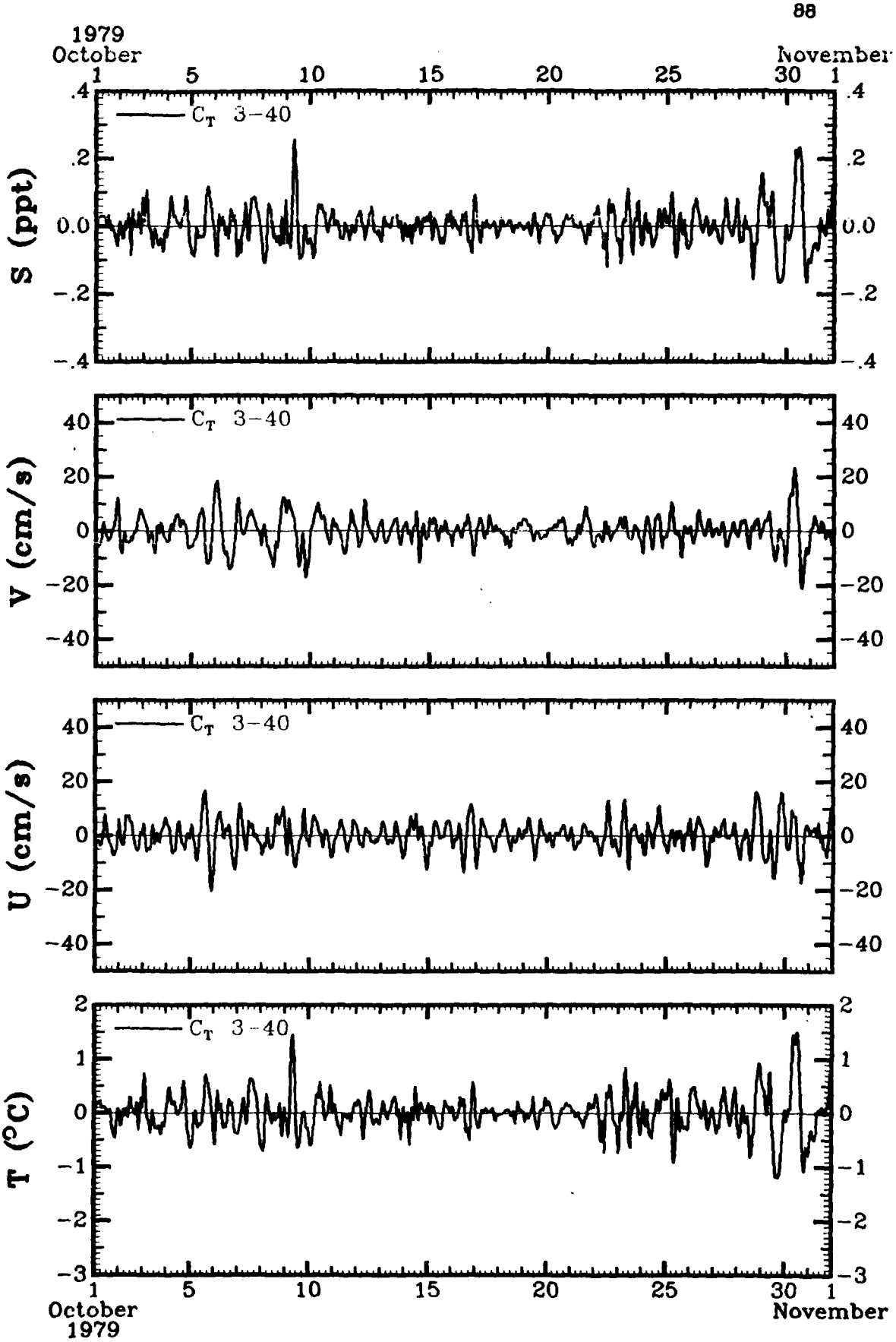

1979
November
December
1
5
10
15
20
25
1
B_B 3-40
S (ppt)
.4
.2
0.0
-.2
-.4
V (cm/s)
U (cm/s)
40
20
0
-20
-40
T (°C)
2
1
0
-1
-2
-3
November
1979
Date/Time

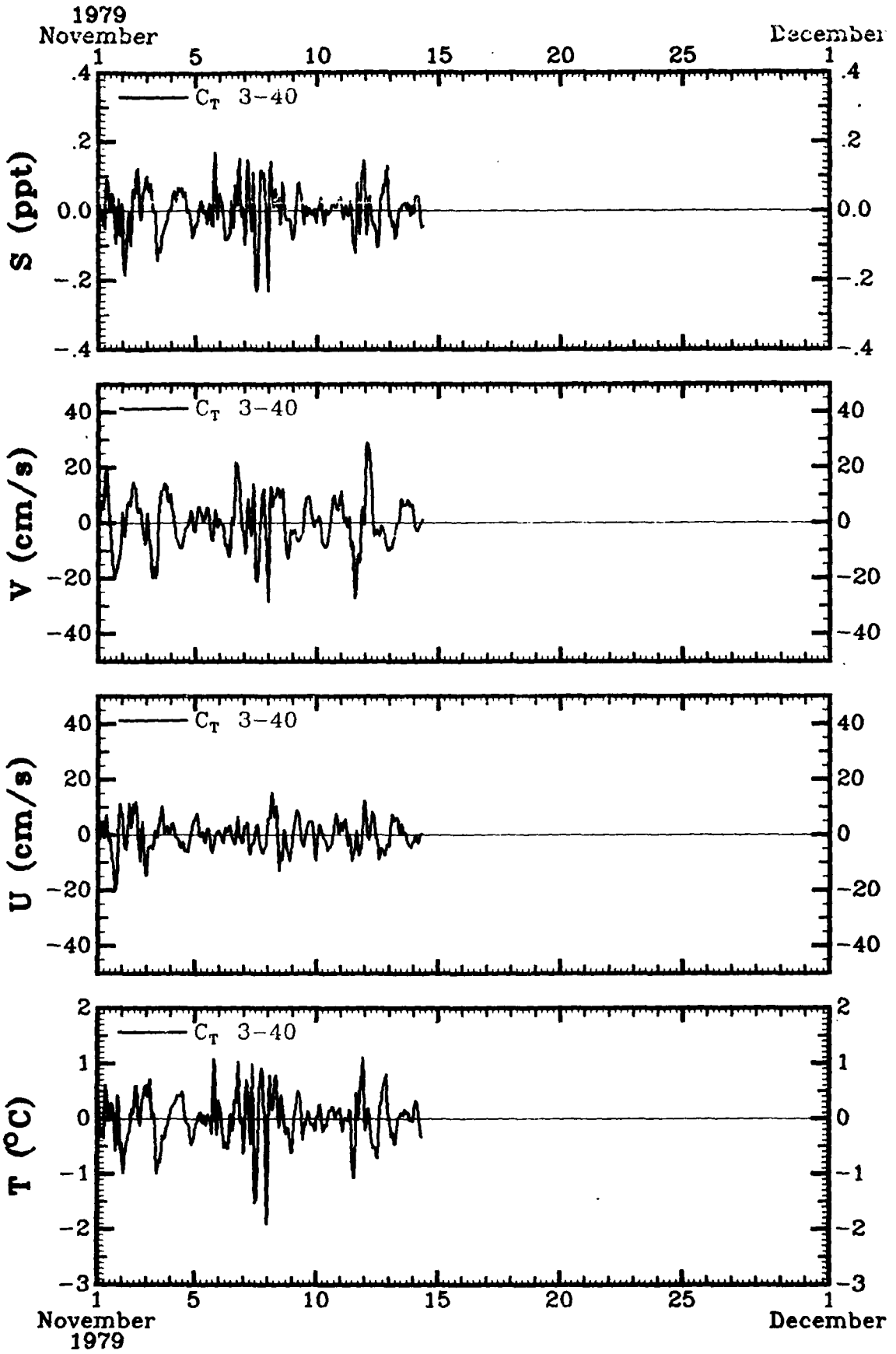
AD-A103 487 NORTH CAROLINA UNIV AT CHAPEL HILL F/G 8/3
THE GULF STREAM MEANDERS EXPERIMENT. CURRENT METER AND ATMOSPHE--ETC(U)
MAY 81 D A BROOKS, J M BANE, R L COHEN N00014-77-C-0354
UNCLASSIFIED NL

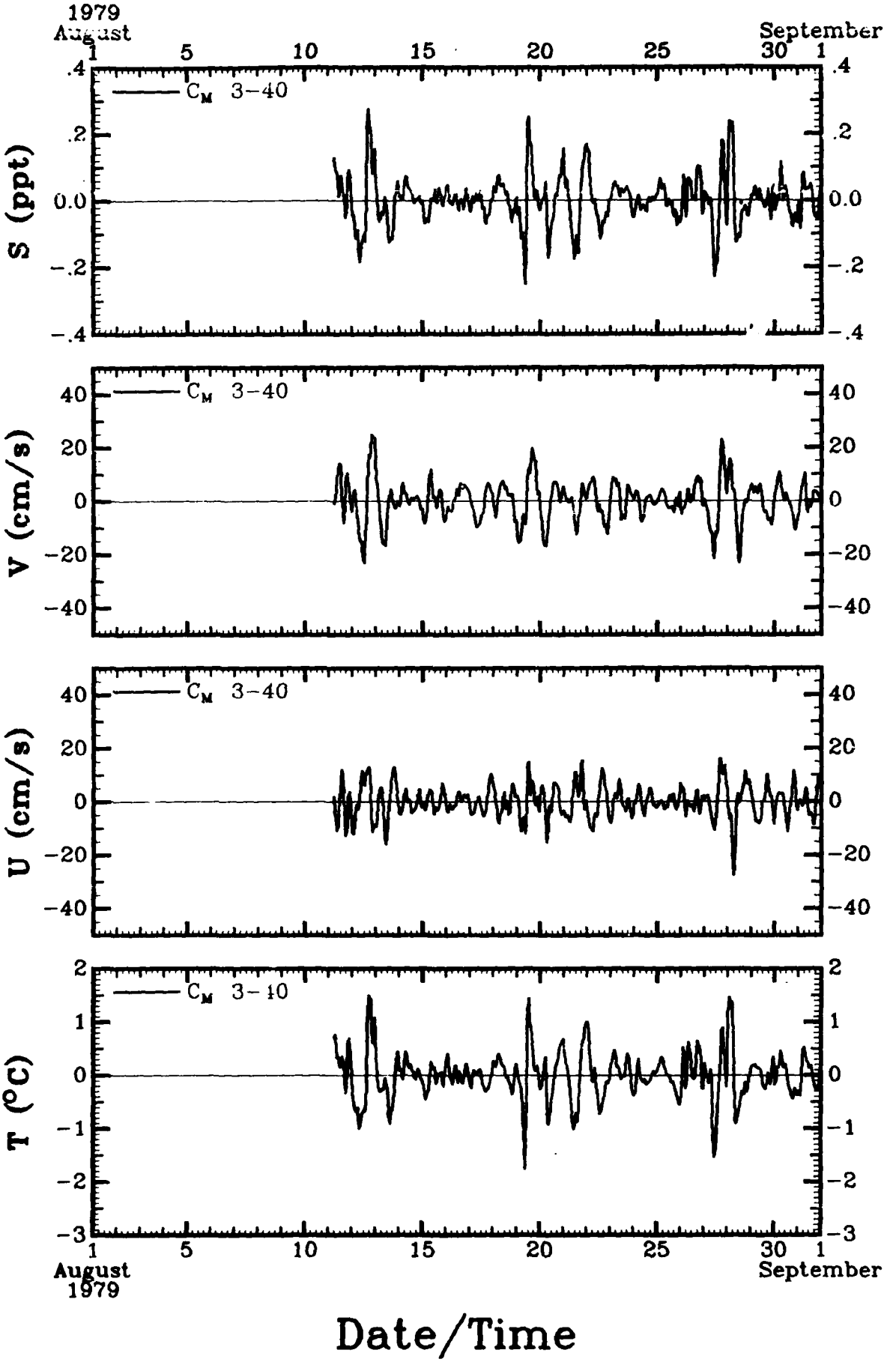


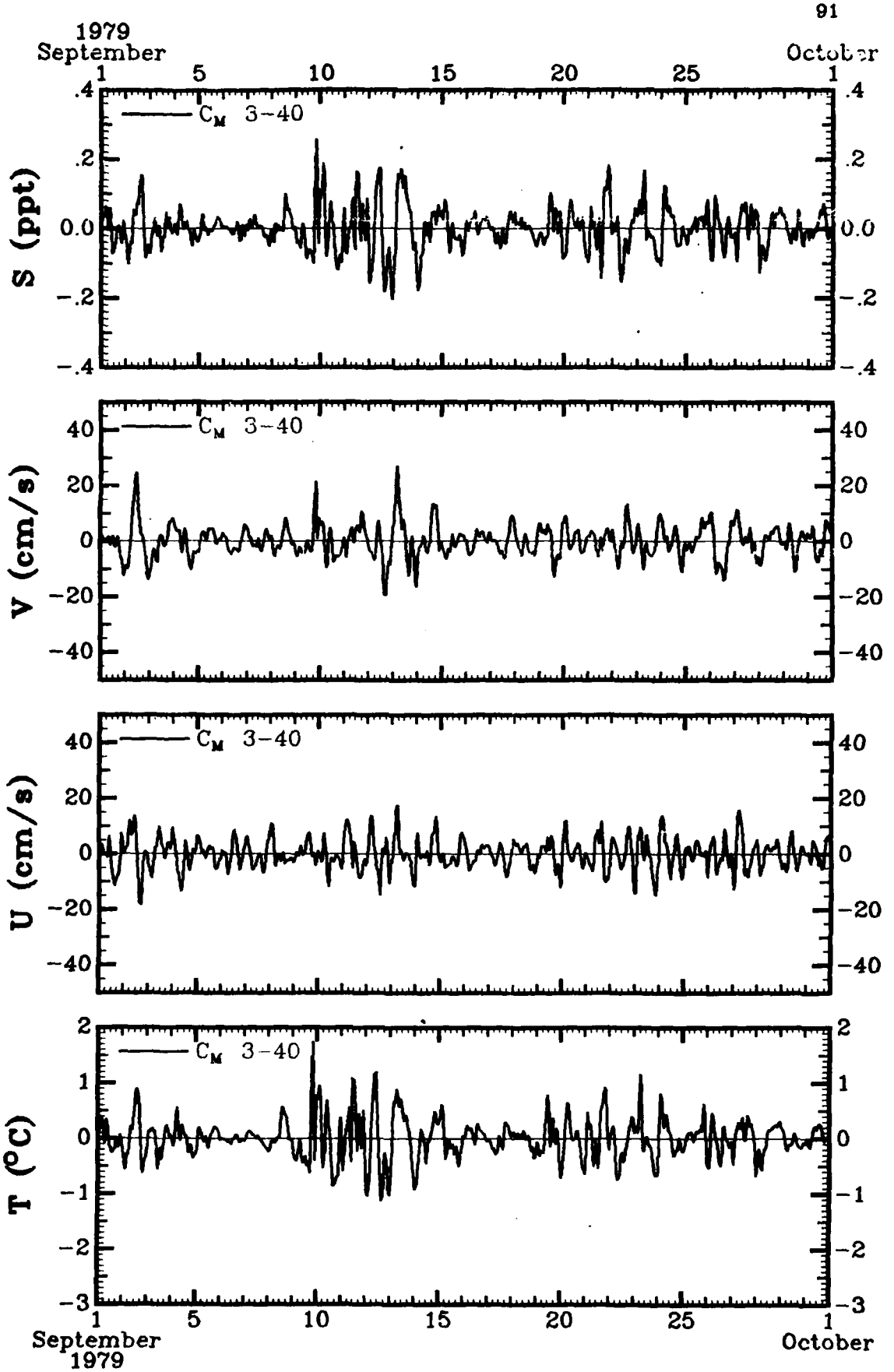

1979
August
September
1
5
10
15
20
25
30
1
C_T 3–40
S (ppt)
V (cm/s)
U (cm/s)
T (°C)
August
1979
September
Date/Time

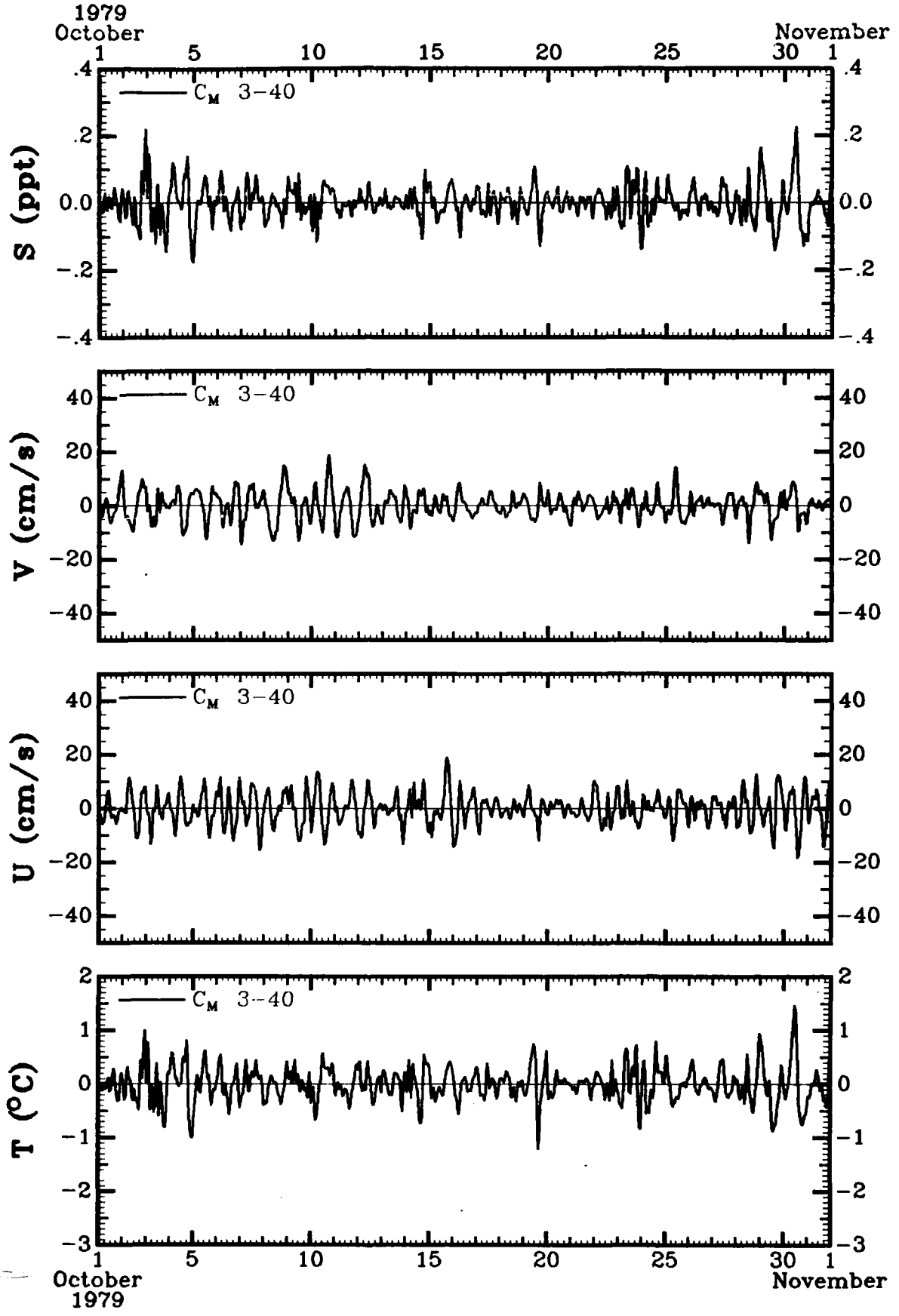

1979
September
October
1
5
10
15
20
25
1
C_T 3-40
S (ppt)
.4
.2
0.0
-.2
-.4
V (cm/s)
40
20
0
-20
-40
U (cm/s)
T (°C)
2
1
0
-1
-2
-3
September
1979
October
Date/Time

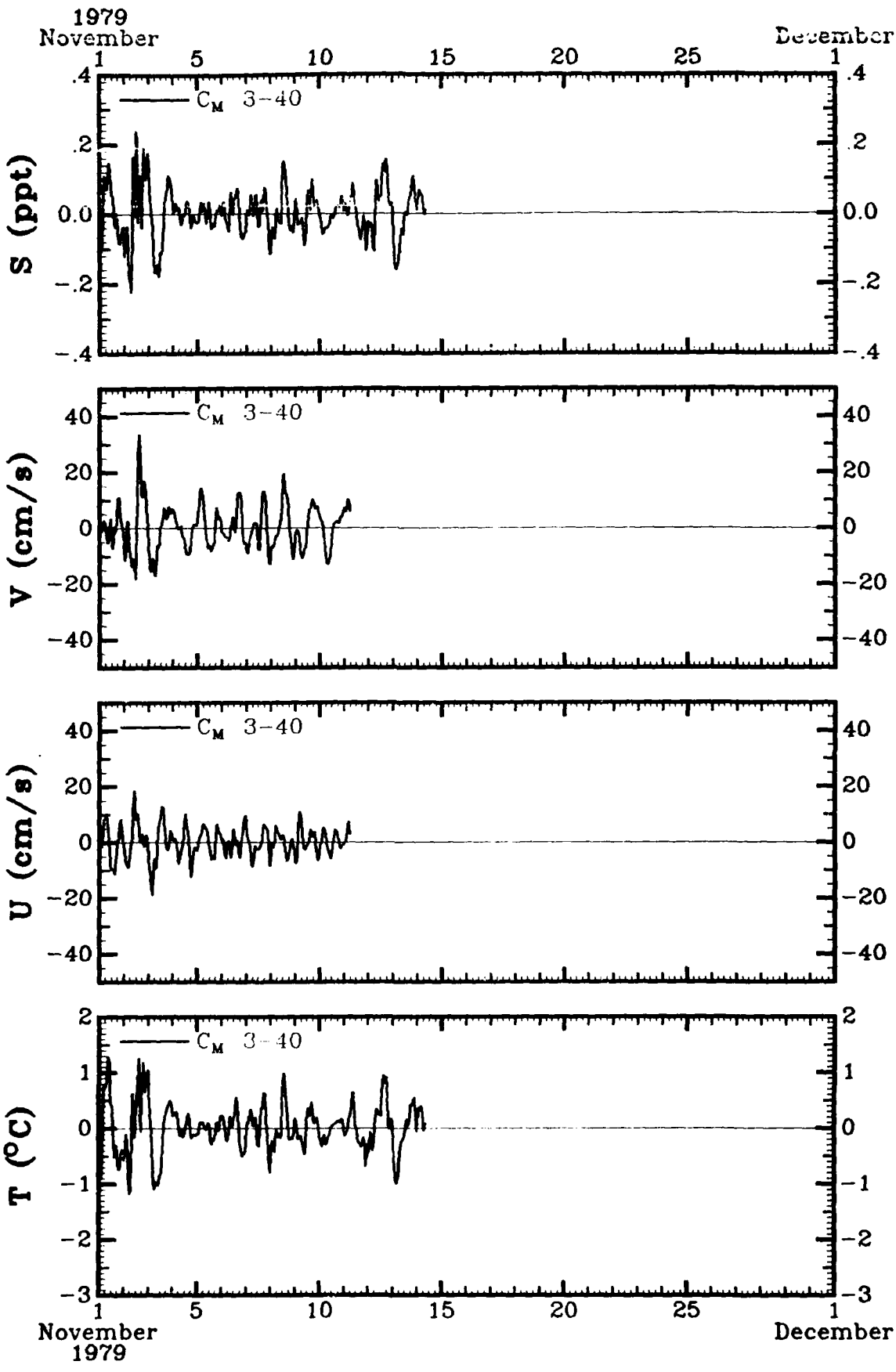

1979
October
November
1 5 10 15 20 25 30 1
C_T 3-40
S (ppt)
.4 .2 0.0 -.2 -.4
V (cm/s)
40 20 0 -20 -40
U (cm/s)
40 20 0 -20 -40
T (°C)
2 1 0 -1 -2 -3
1 5 10 15 20 25 30 1
October
1979
November
Date/Time

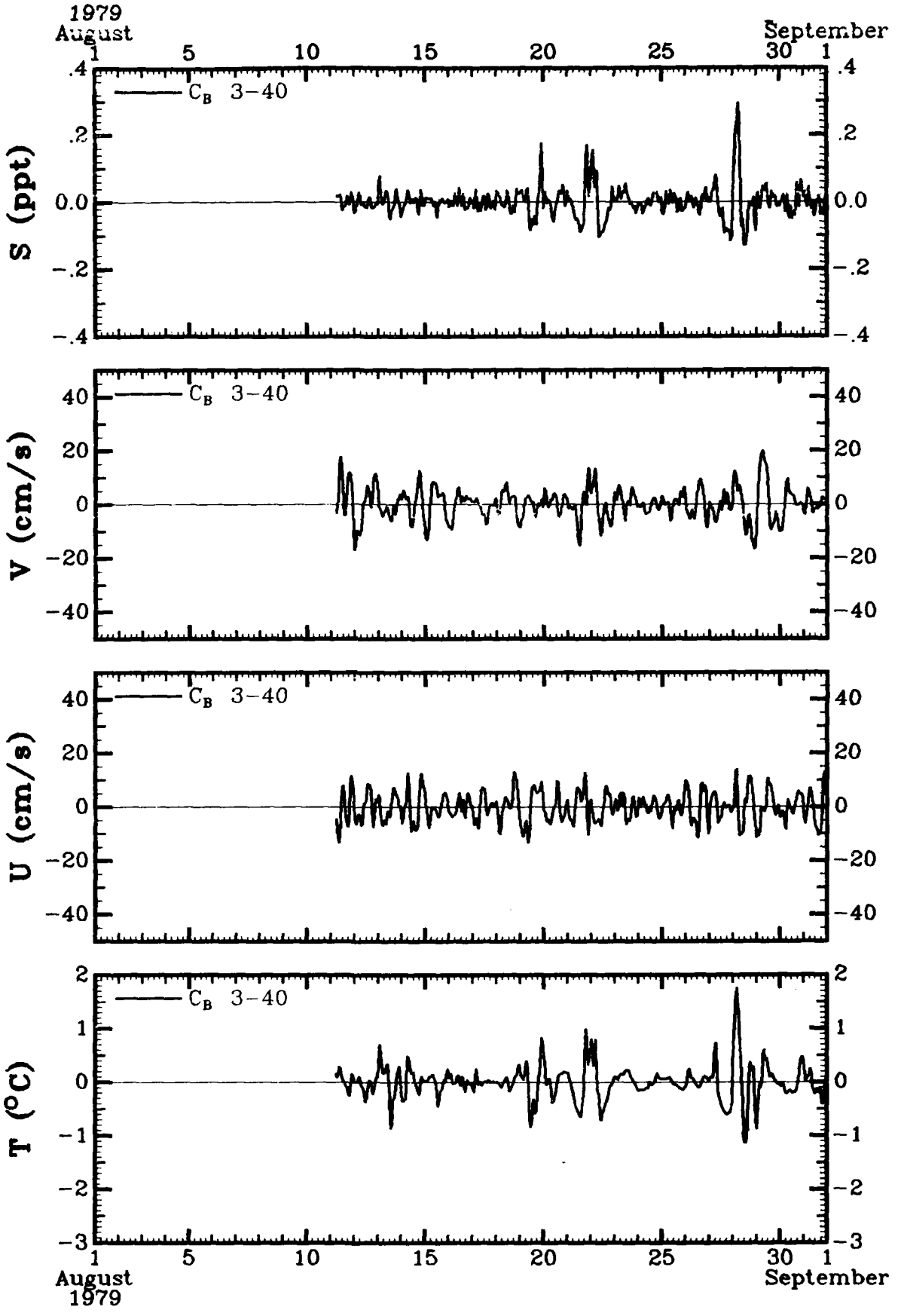

1979
November
December
1
5
10
15
20
25
1
C_T 3-40
S (ppt)
.4
.2
0.0
-.2
-.4
V (cm/s)
40
20
0
-20
-40
U (cm/s)
T (°C)
2
1
0
-1
-2
-3
November
1979
December
Date/Time

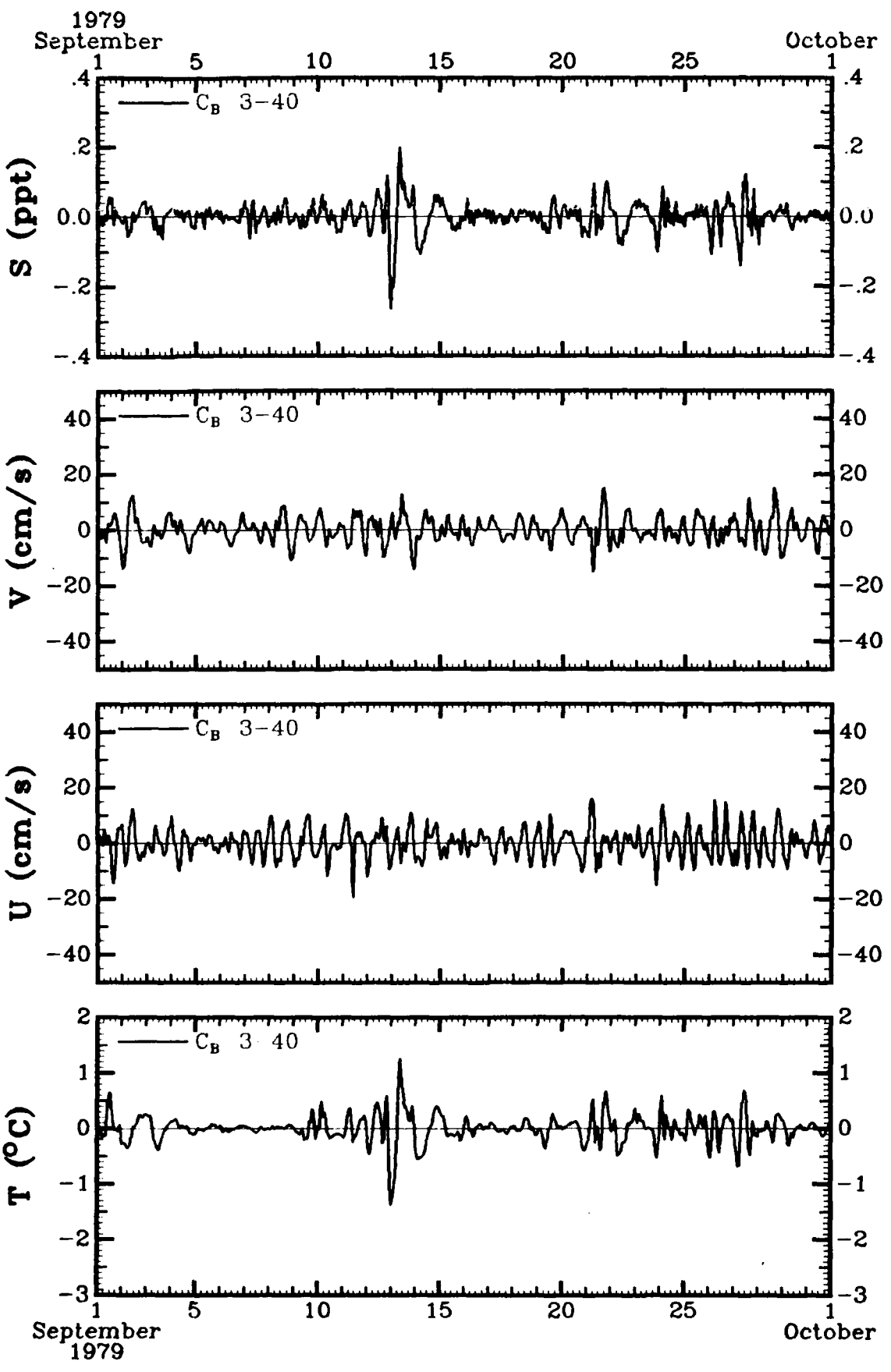

1979
August
September
1 5 10 15 20 25 30 1
S (ppt)
V (cm/s)
U (cm/s)
T (°C)
C_M 3-40
C_M 3-40
C_M 3-40
C_M 3-10
.4
.2
0.0
-.2
-.4
40
20
0
-20
-40
2
1
0
-1
-2
-3
1 5 10 15 20 25 30 1
August
1979
September
Date/Time

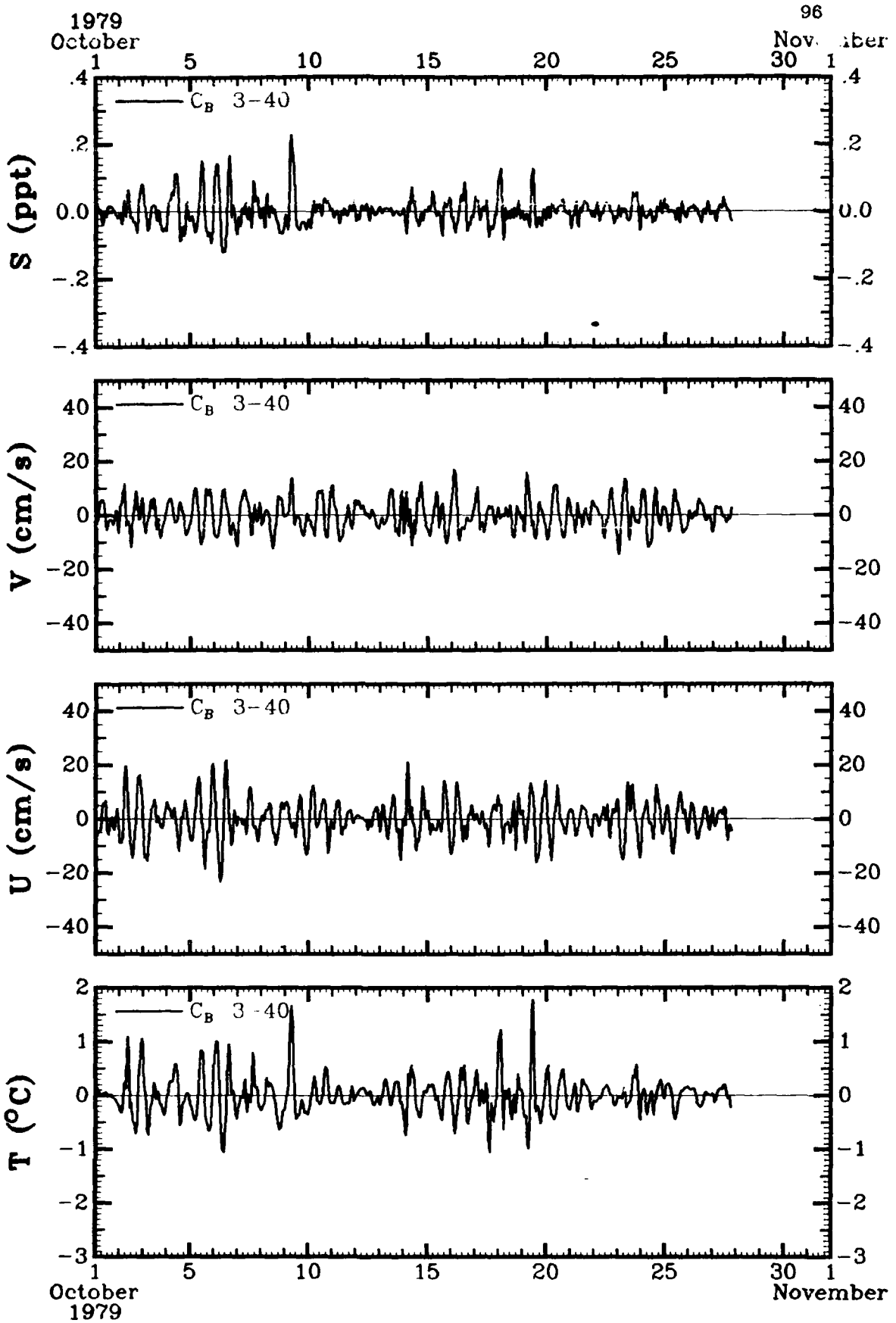

1979
September
October
1
5
10
15
20
25
1
C_M 3–40
S (ppt)
.4
.2
0.0
–.2
–.4
V (cm/s)
40
20
0
–20
–40
U (cm/s)
T (°C)
2
1
0
–1
–2
–3
September
1979
October
Date/Time

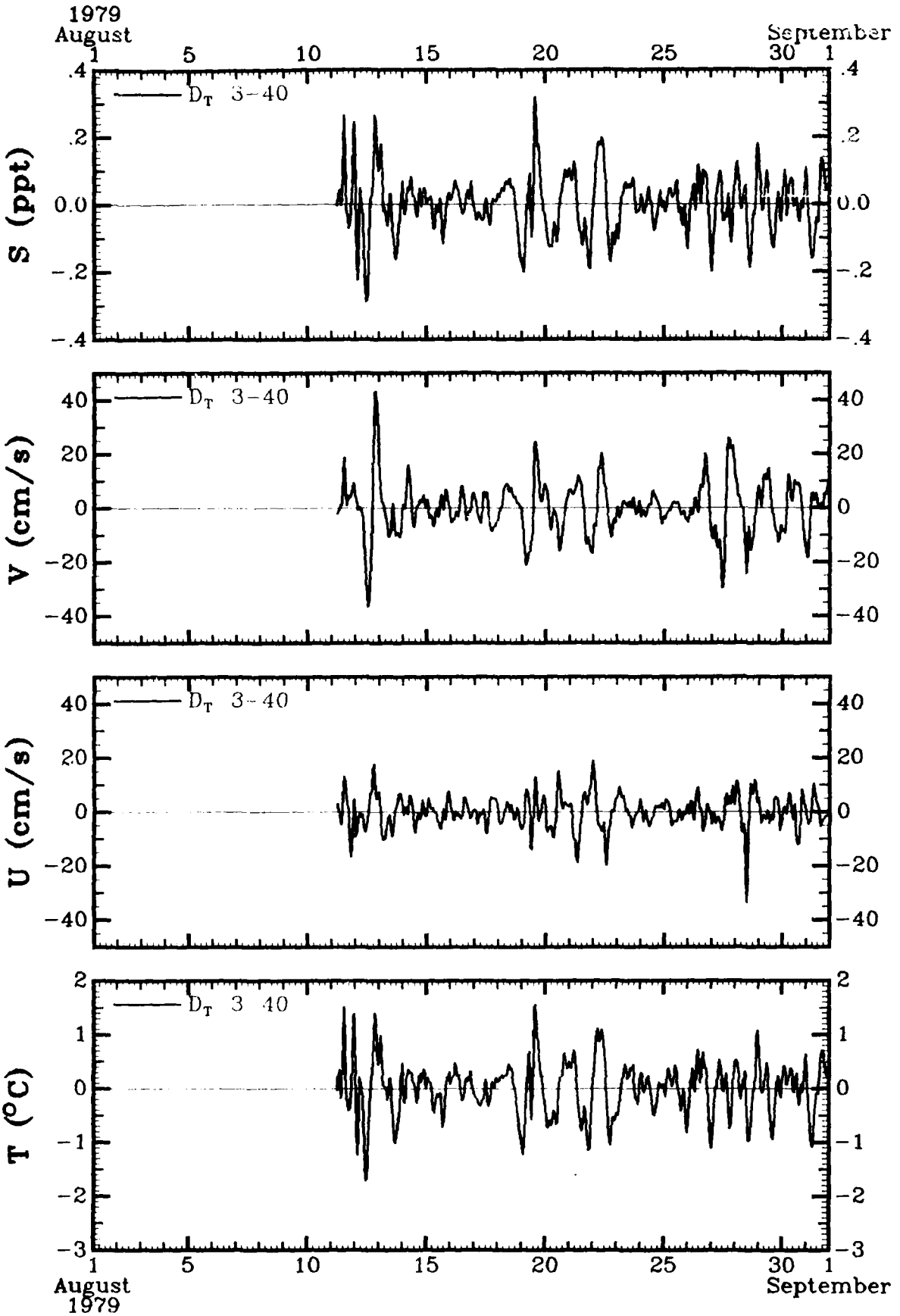

1979
October
November
1 5 10 15 20 25 30 1
S (ppt)
V (cm/s)
U (cm/s)
T (°C)
C_M 3–40
.4
.2
0.0
−.2
−.4
40
20
0
−20
−40
2
1
0
−1
−2
−3
1 5 10 15 20 25 30 1
October
1979
November
Date/Time

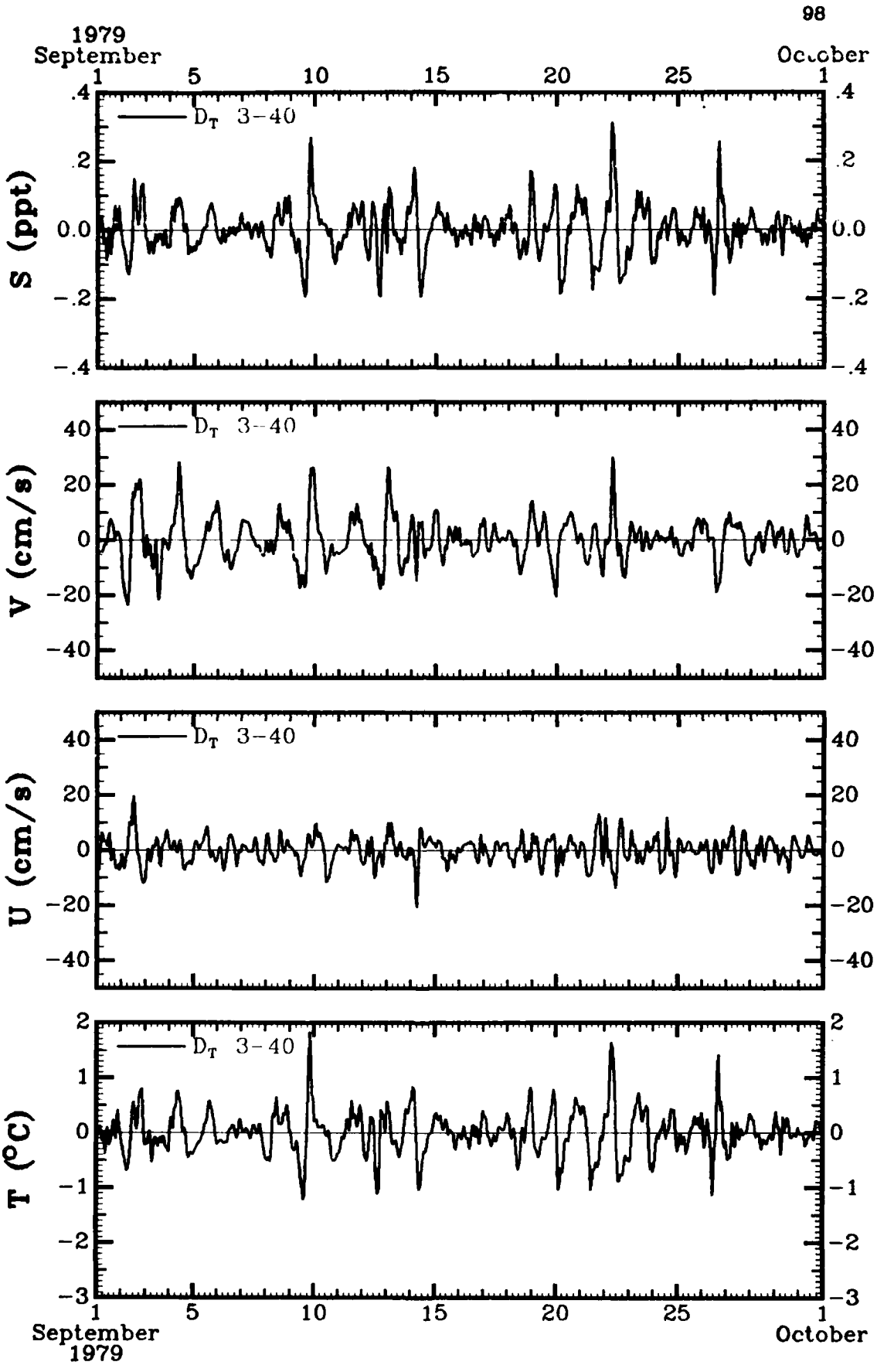

1979
November
December
1
5
10
15
20
25
1
C_M 3-40
S (ppt)
.4
.2
0.0
-.2
-.4
V (cm/s)
40
20
0
-20
-40
U (cm/s)
T (°C)
2
1
0
-1
-2
-3
November
1979
December
Date/Time

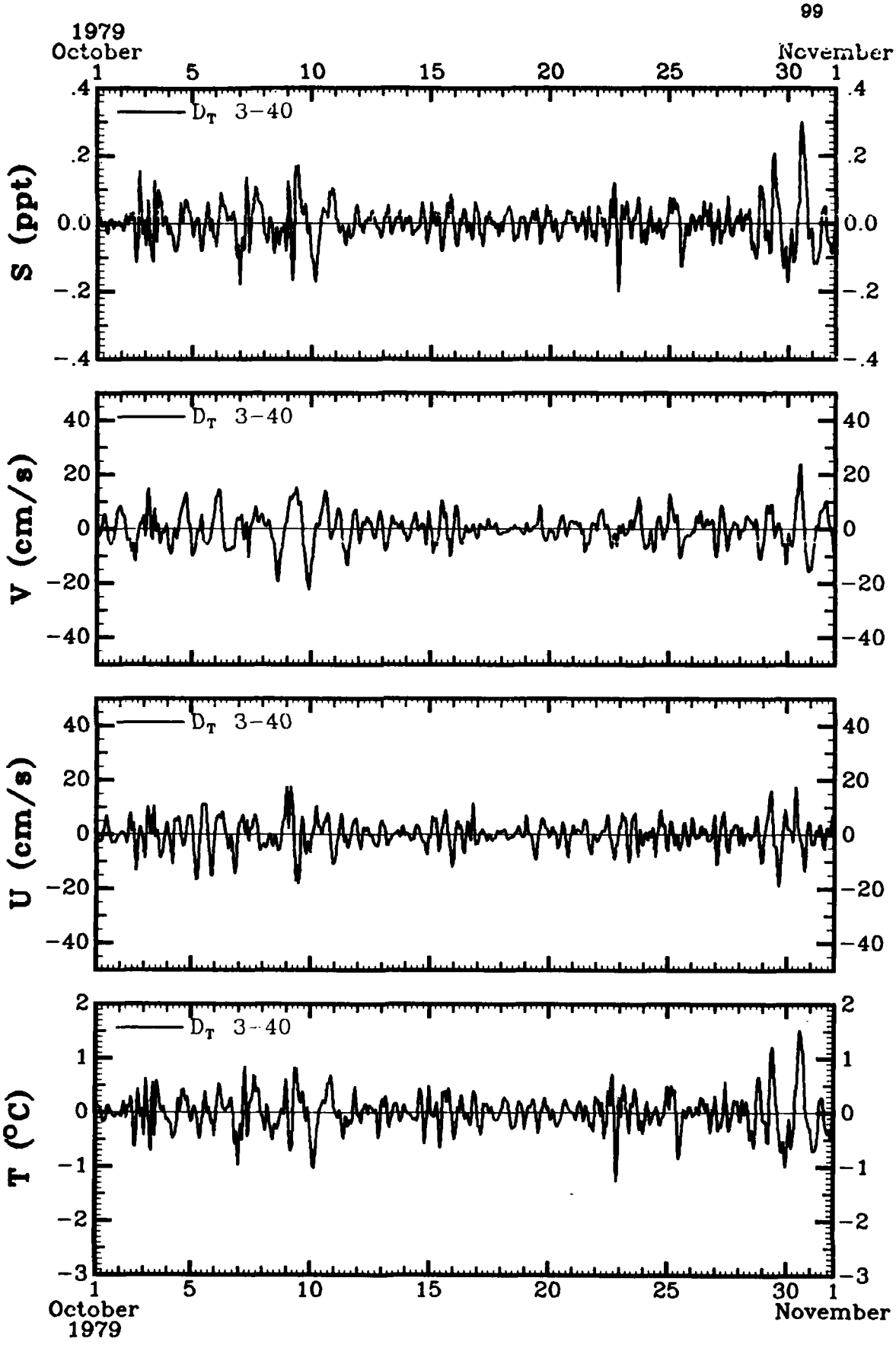

1979
August
September
1 5 10 15 20 25 30 1
S (ppt)
V (cm/s)
U (cm/s)
T (°C)
C_B 3-40
.4
.2
0.0
-.2
-.4
40
20
0
-20
-40
2
1
-1
-2
-3
August
1979
September
Date/Time

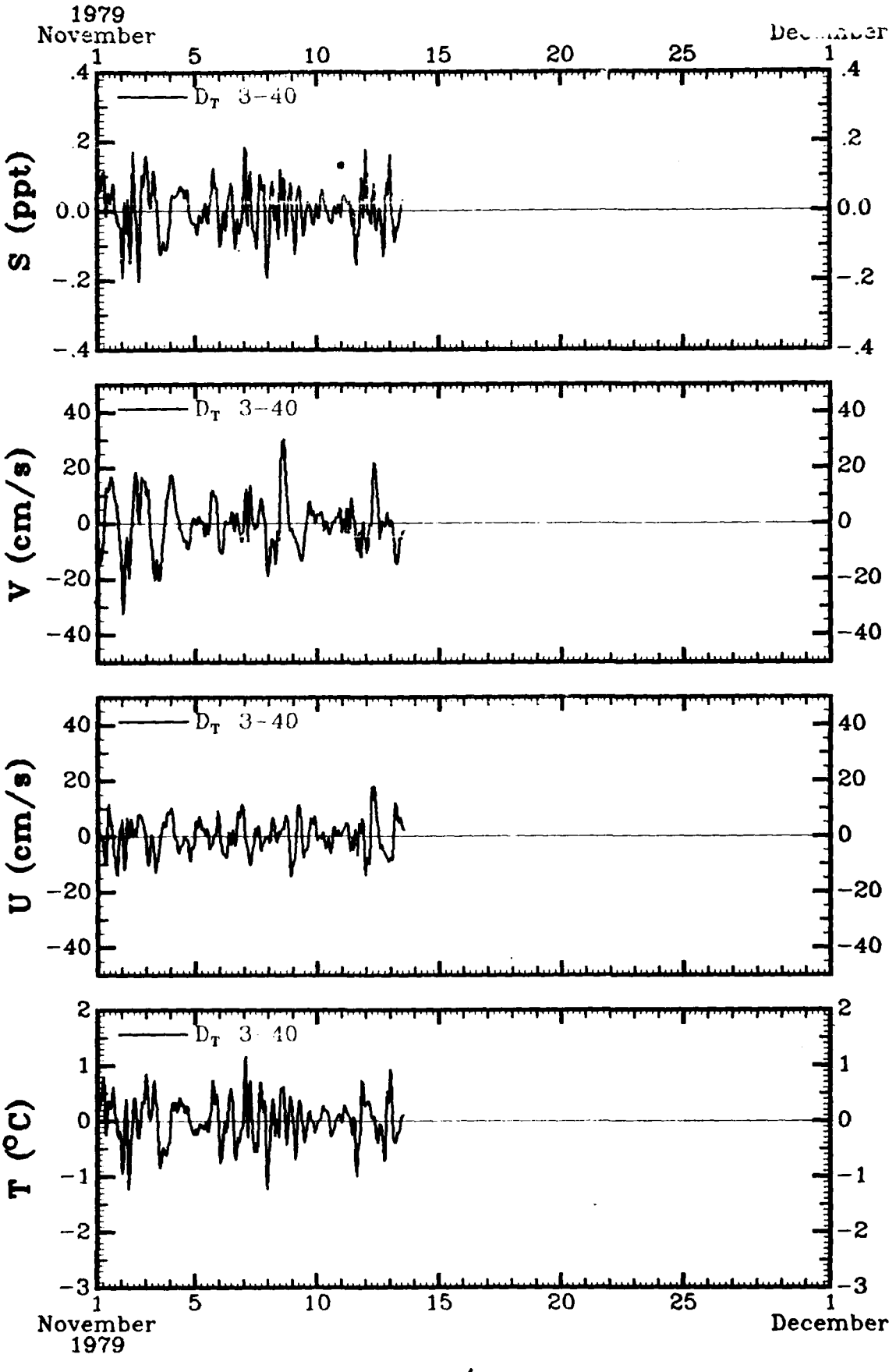

1979
September
October
1
5
10
15
20
25
1
C_B 3-40
S (ppt)
.4
.2
0.0
-.2
-.4
V (cm/s)
40
20
0
-20
-40
U (cm/s)
T (°C)
2
1
0
-1
-2
-3
September
1979
Date/Time


1979
October
November
1
5
10
15
20
25
30
S (ppt)
V (cm/s)
U (cm/s)
T (°C)
C_B 3-40
October
1979
November
Date/Time


1979
August
September
1 5 10 15 20 25 30 1
D_T 3-40
S (ppt)
.4 .2 0.0 -.2 -.4
V (cm/s)
40 20 0 -20 -40
U (cm/s)
40 20 0 -20 -40
T (°C)
2 1 0 -1 -2 -3
1 5 10 15 20 25 30 1
August
1979
September
Date/Time


1979
September
October
1
5
10
15
20
25
1
S (ppt)
V (cm/s)
U (cm/s)
T (°C)
D_T 3-40
.4
.2
0.0
-.2
-.4
40
20
0
-20
-40
2
1
0
-1
-2
-3
September
1979
October
Date/Time

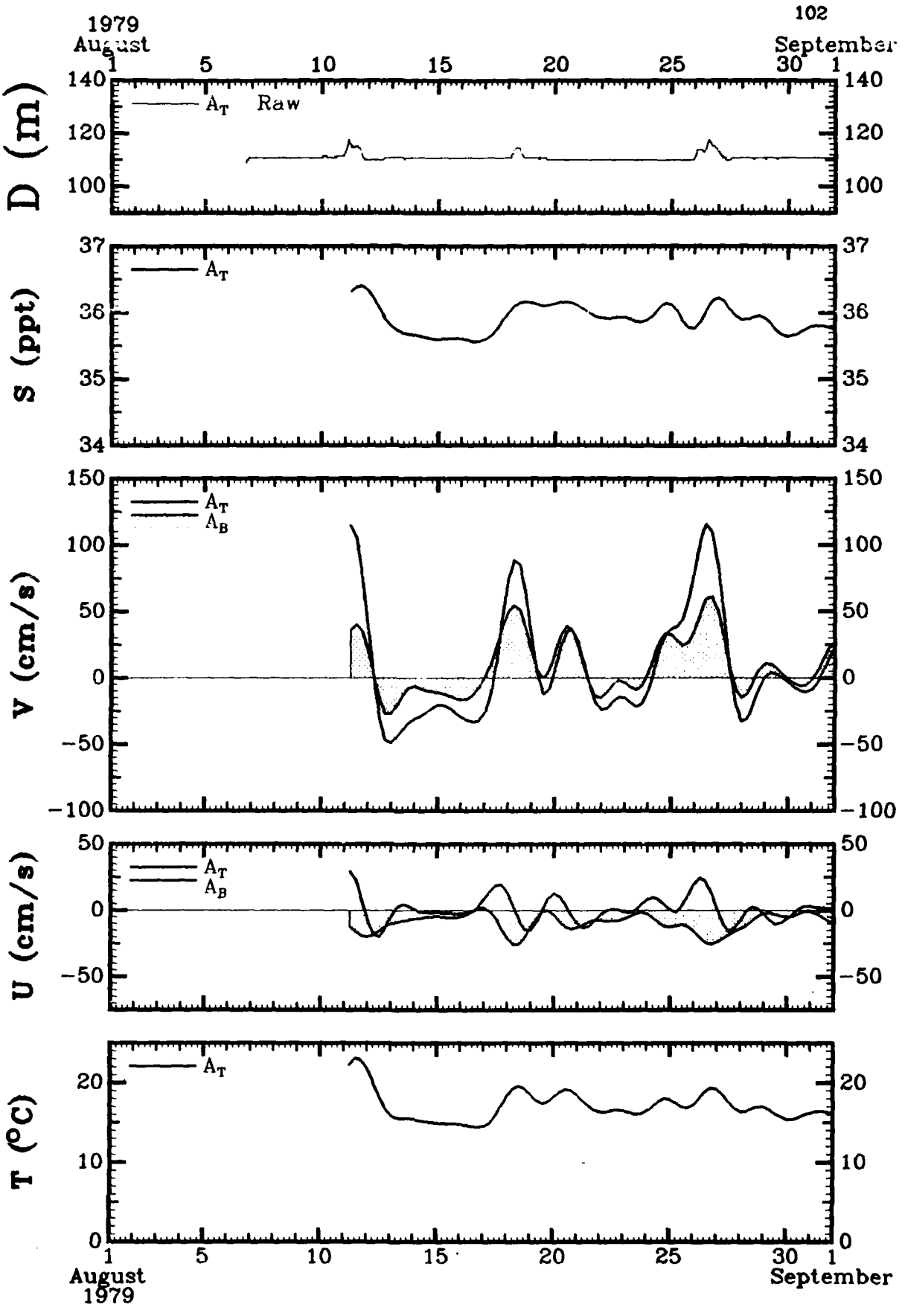

1979
October
November
1 5 10 15 20 25 30 1
S (ppt)
V (cm/s)
U (cm/s)
T (°C)
D_T 3–40
.4
.2
0.0
−.2
−.4
40
20
0
−20
−40
2
1
−1
−2
−3
October
1979
November
Date/Time

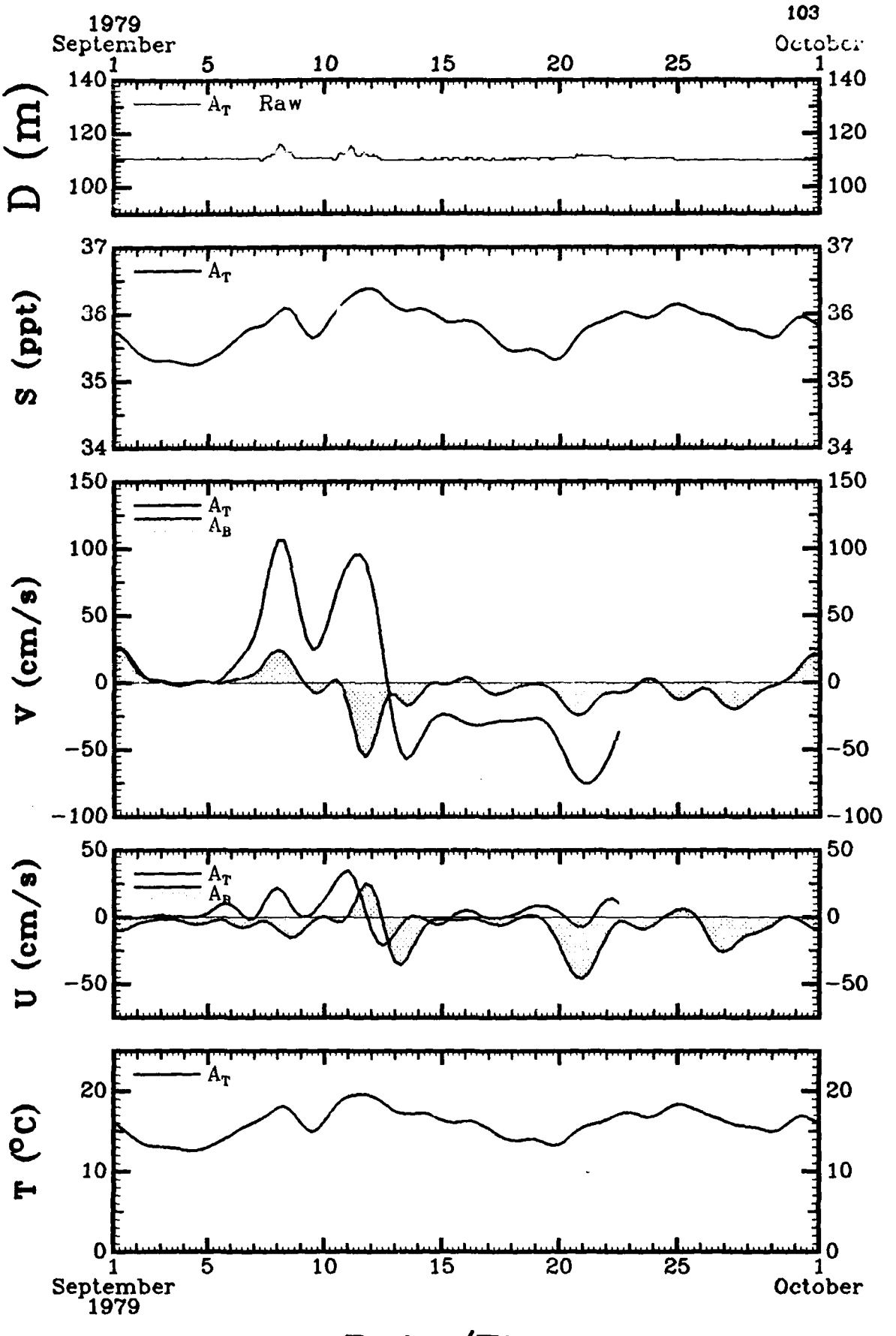

1979
November
December
1
5
10
15
20
25
1
D_T 3-40
S (ppt)
.4
.2
0.0
-.2
-.4
V (cm/s)
40
20
0
-20
-40
U (cm/s)
T (°C)
2
1
0
-1
-2
-3
November
1979
December
Date/Time

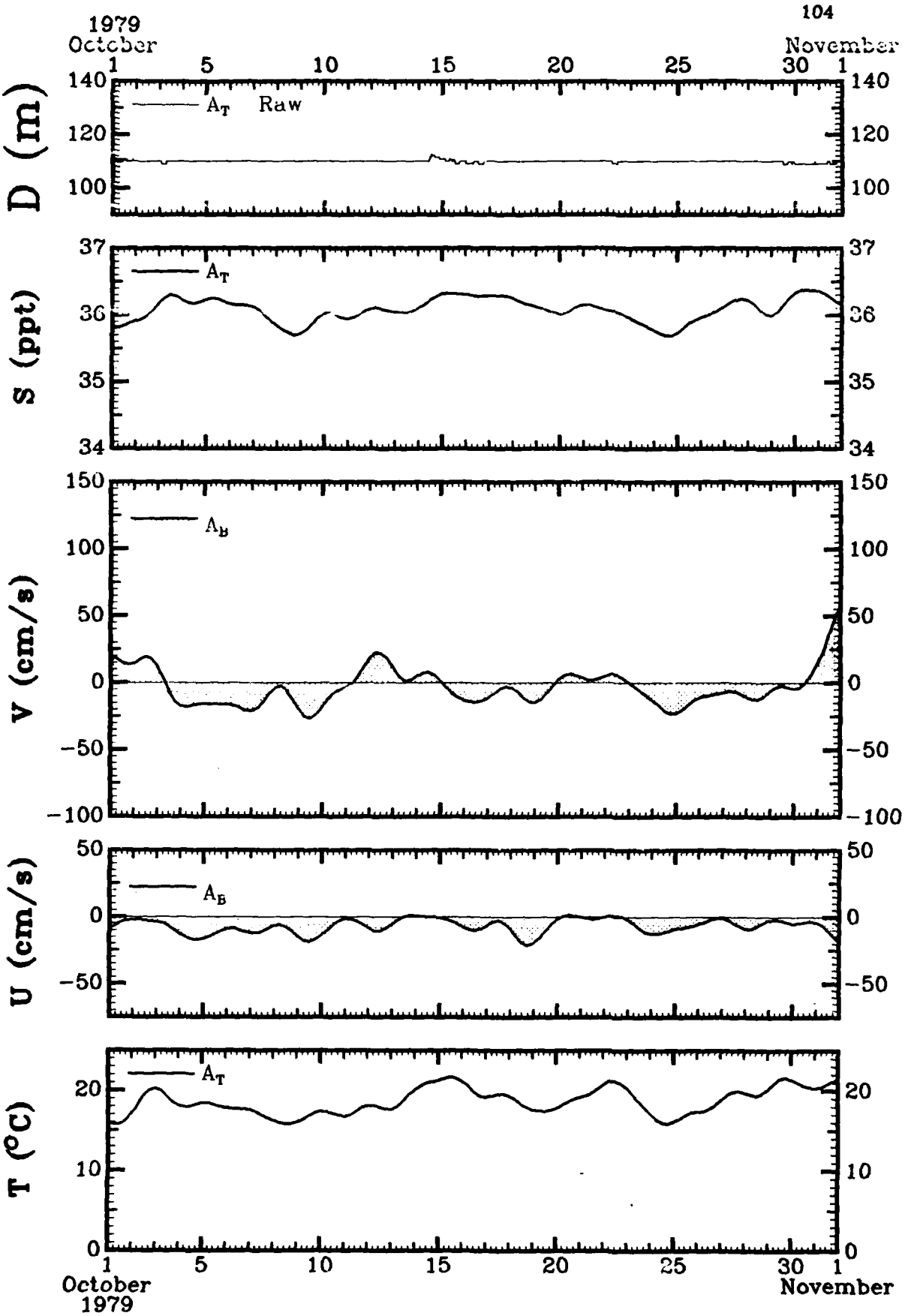
SECTION 5

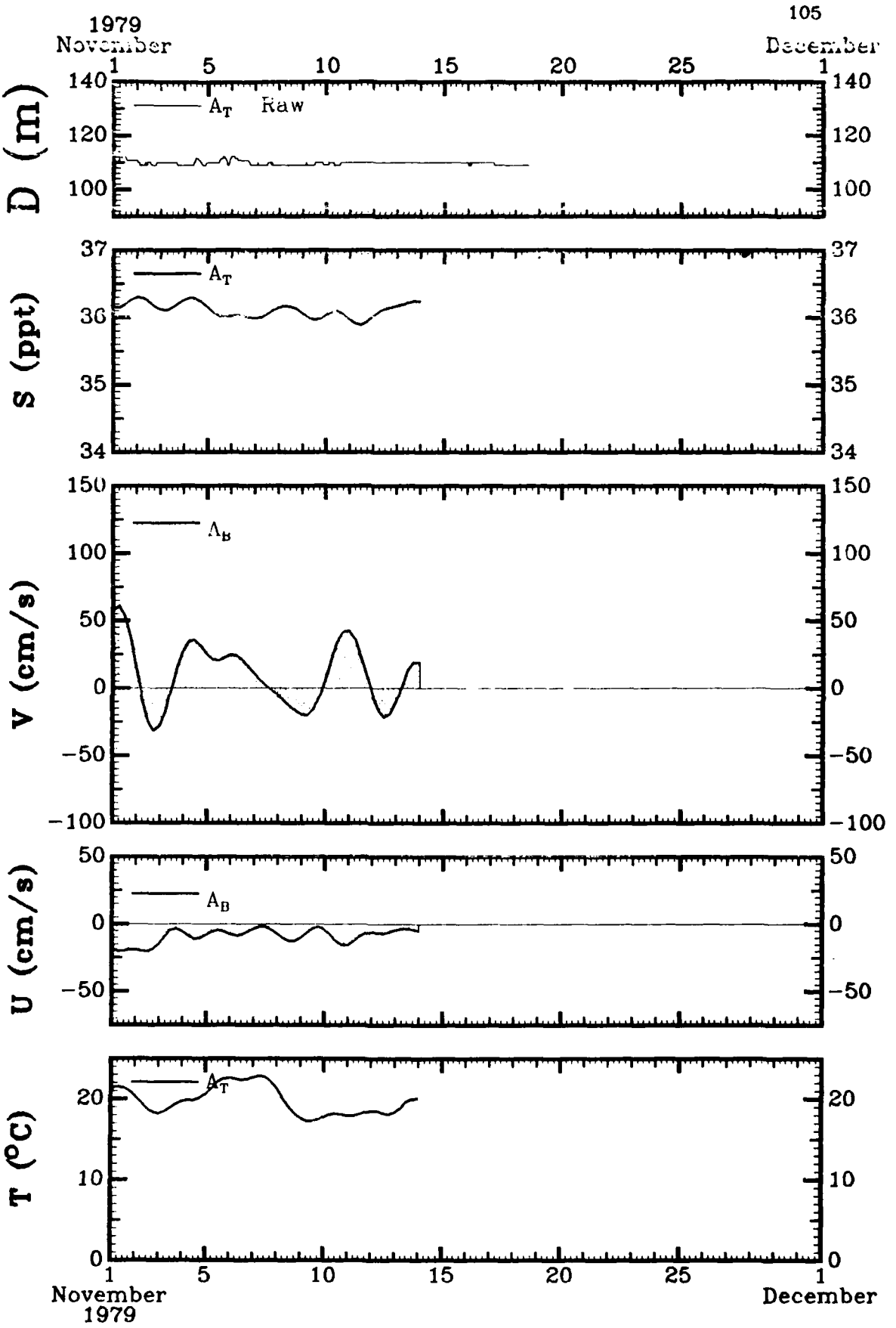
40 HRLP Data for Each Mooring

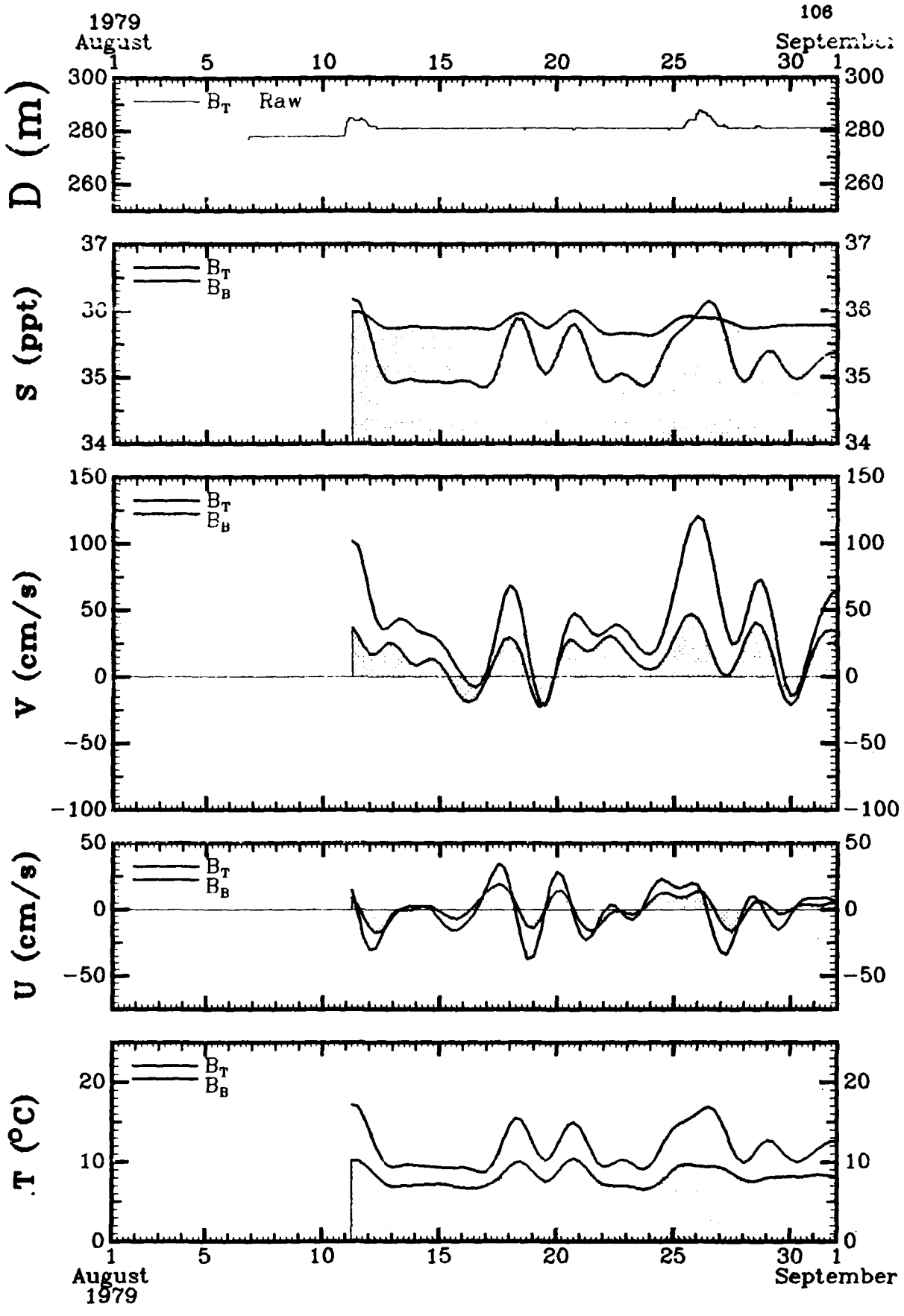
Figures 31 through 34 show the raw pressure data (converted to depth units) and the 40 HRLP current meter data by month for each mooring, superimposing similar data from each instrument on the mooring. Common scaling is used in this section.

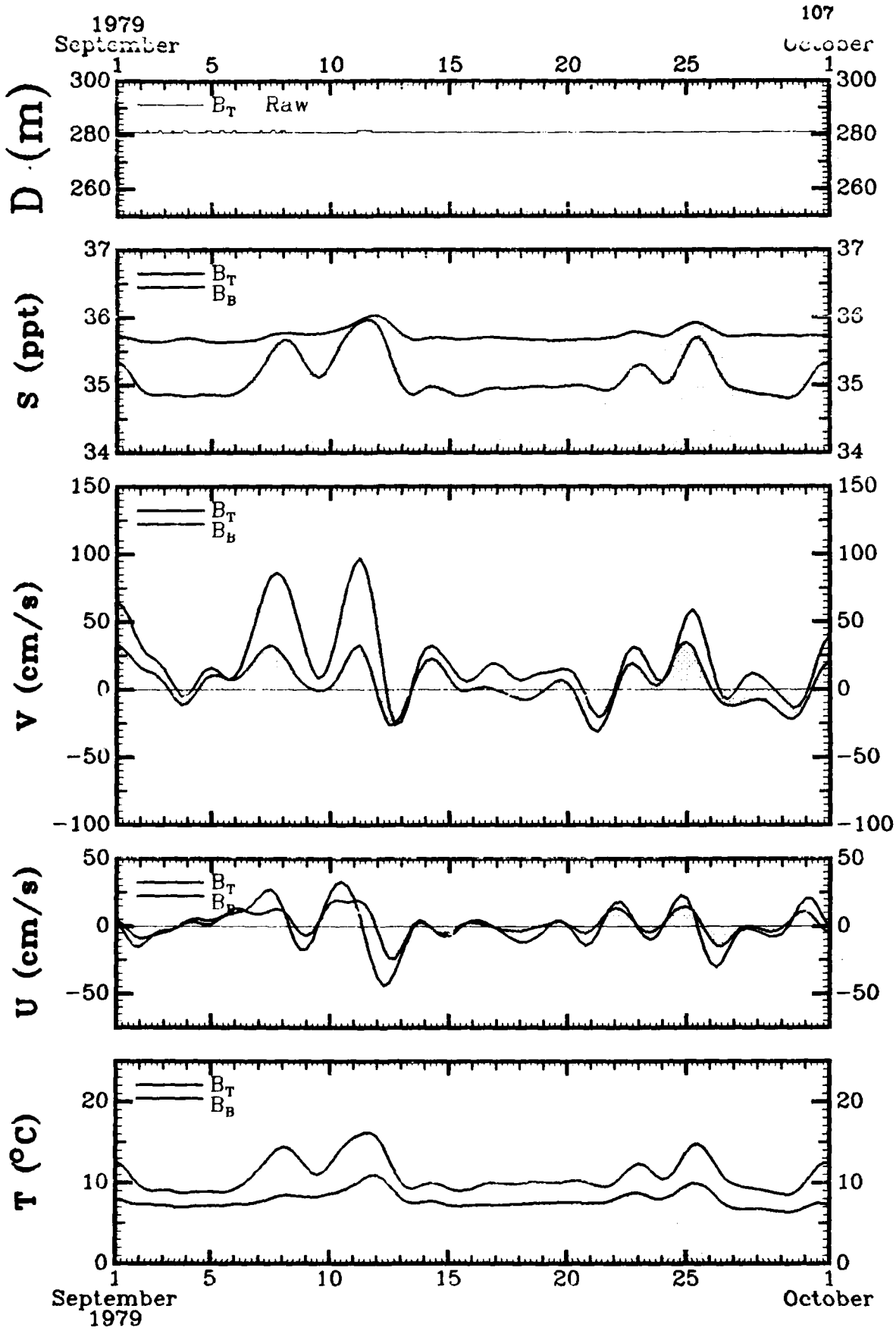

1979
August
September
1
5
10
15
20
25
30
1
D (m)
140
120
100
A_T Raw
S (ppt)
37
36
35
34
A_T
V (cm/s)
150
100
50
0
−50
−100
A_T
A_B
U (cm/s)
50
0
−50
A_T
A_B
T (°C)
20
10
0
A_T
August
1979
September
Date/Time

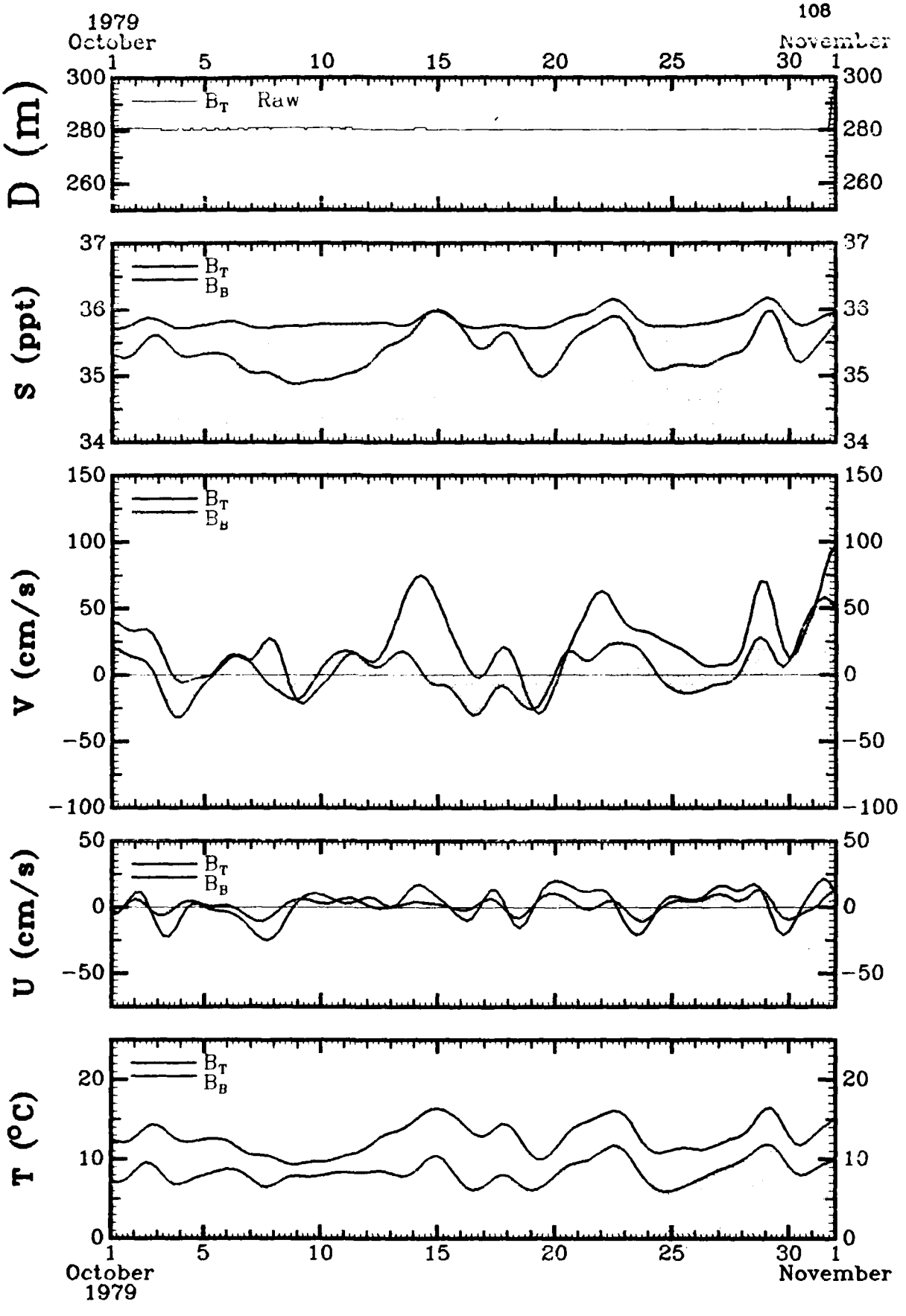

1979
September
October
1
5
10
15
20
25
1
D (m)
140
120
100
A_T Raw
S (ppt)
37
36
35
34
A_T
V (cm/s)
150
100
50
0
−50
−100
A_T
A_B
U (cm/s)
50
0
−50
A_T
A_B
T (°C)
20
10
0
A_T
September
1979
October
Date/Time

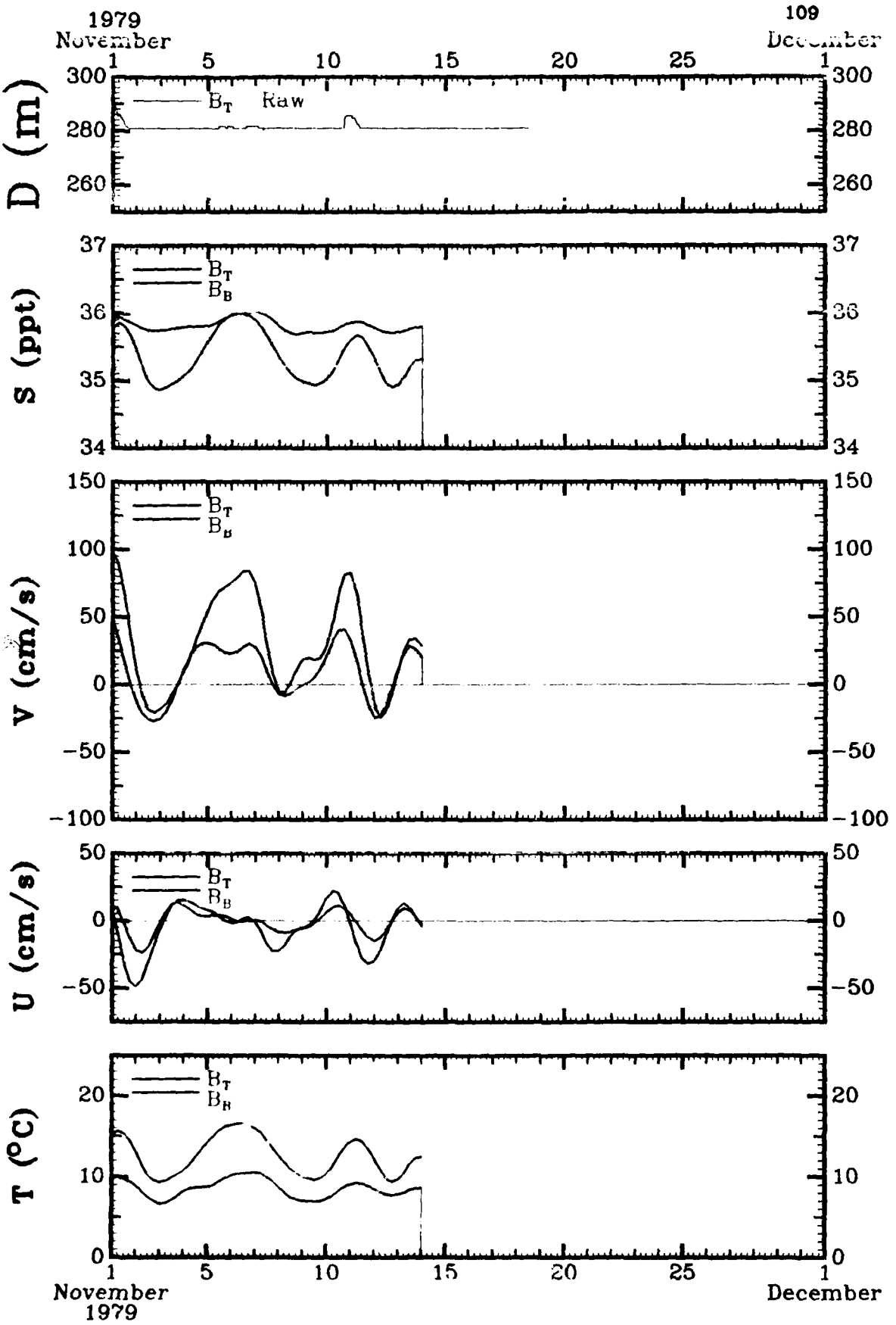

1979
October
November
1
5
10
15
20
25
30
1
D (m)
140
120
100
A_T Raw
S (ppt)
37
36
35
34
A_T
V (cm/s)
150
100
50
0
−50
−100
A_B
U (cm/s)
50
0
−50
A_B
T (°C)
20
10
0
A_T
October
1979
November
Date/Time

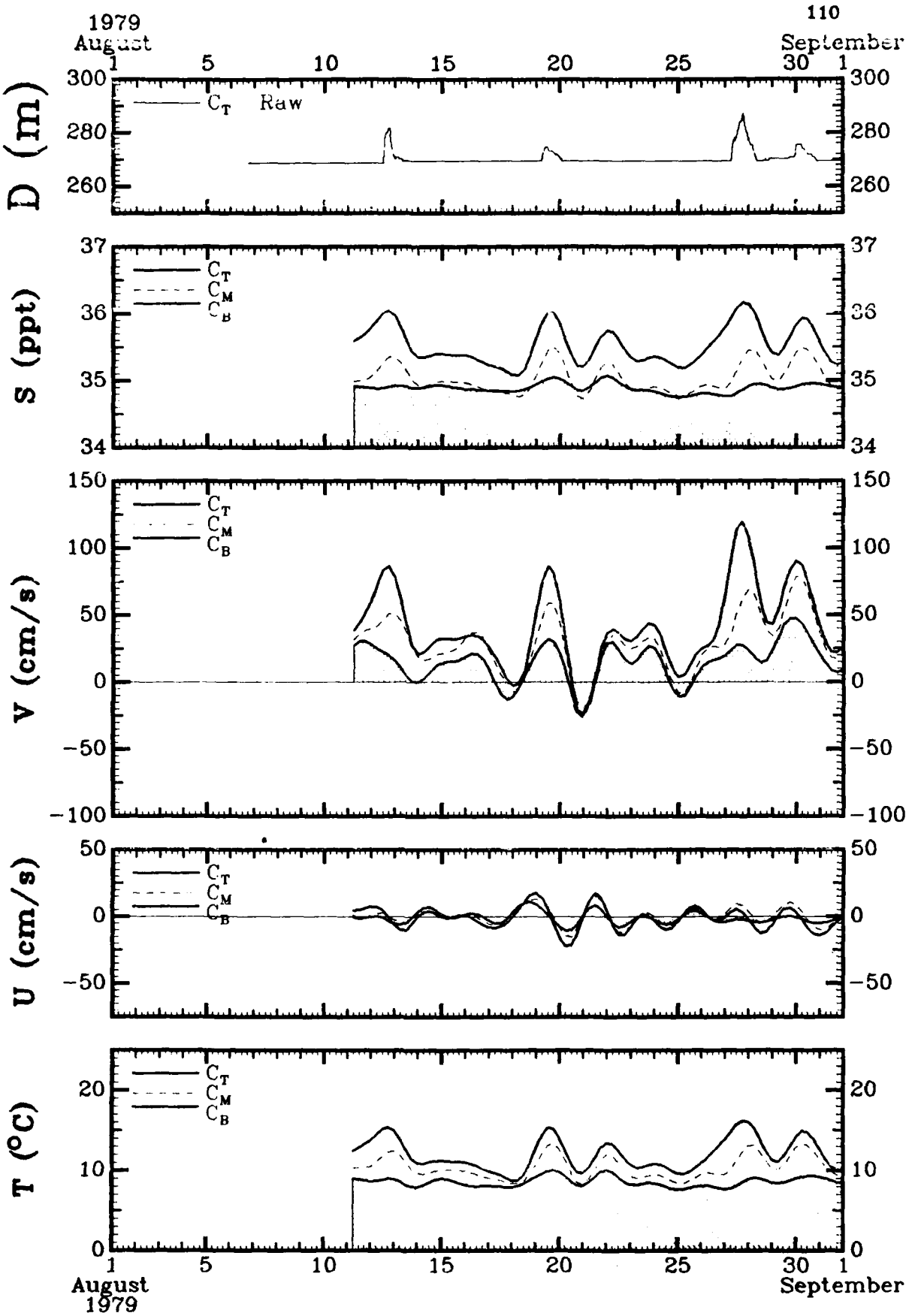

1979
November
December
1
5
10
15
20
25
1
D (m)
140
120
100
A_T Raw
S (ppt)
37
36
35
34
A_T
V (cm/s)
150
100
50
0
−50
−100
A_B
U (cm/s)
50
0
−50
A_B
T (°C)
20
10
0
A_T
1
November
1979
Date/Time

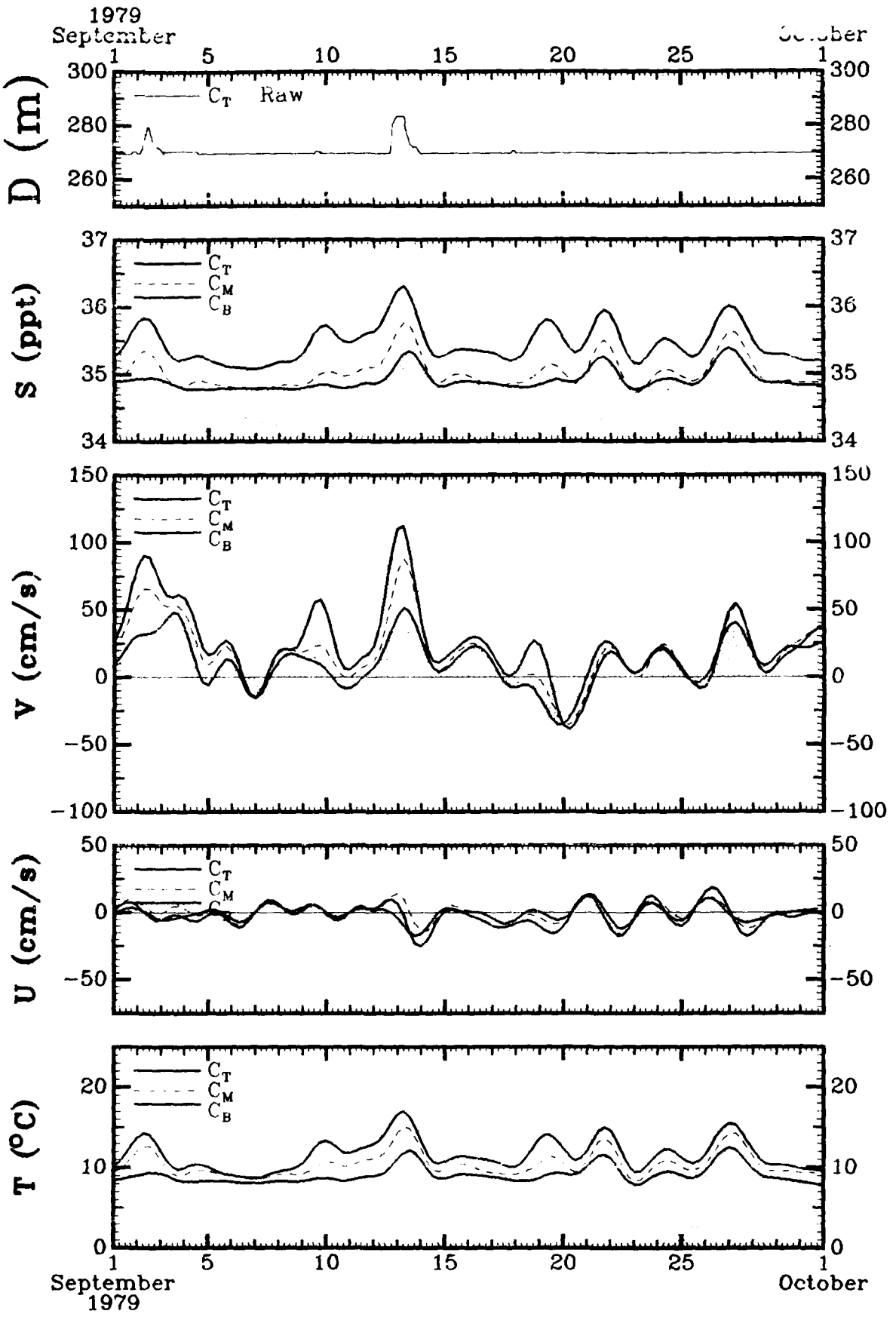

1979
August
September
1
5
10
15
20
25
30
1
D (m)
300
280
260
B_T
Raw
S (ppt)
37
36
35
34
B_T
B_B
V (cm/s)
150
100
50
0
−50
−100
B_T
B_B
U (cm/s)
50
0
−50
B_T
B_B
T (°C)
20
10
0
B_T
B_B
August
1979
September
Date/Time

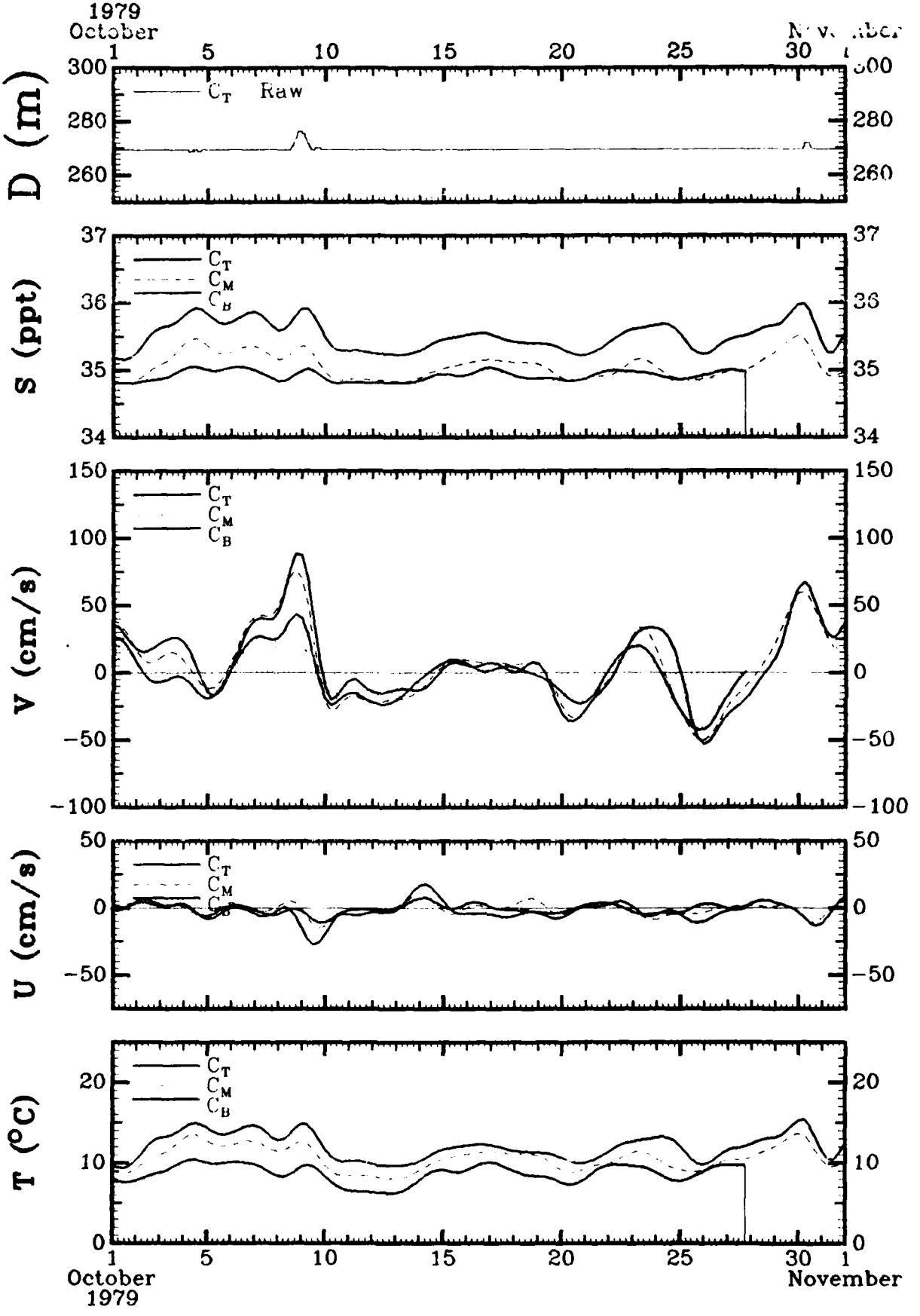

1979
September
October
1
5
10
15
20
25
1
D (m)
300
280
260
B_T Raw
S (ppt)
37
36
35
34
B_T
B_B
V (cm/s)
150
100
50
0
−50
−100
U (cm/s)
T (°C)
20
10
0
September
1979
October
Date/Time

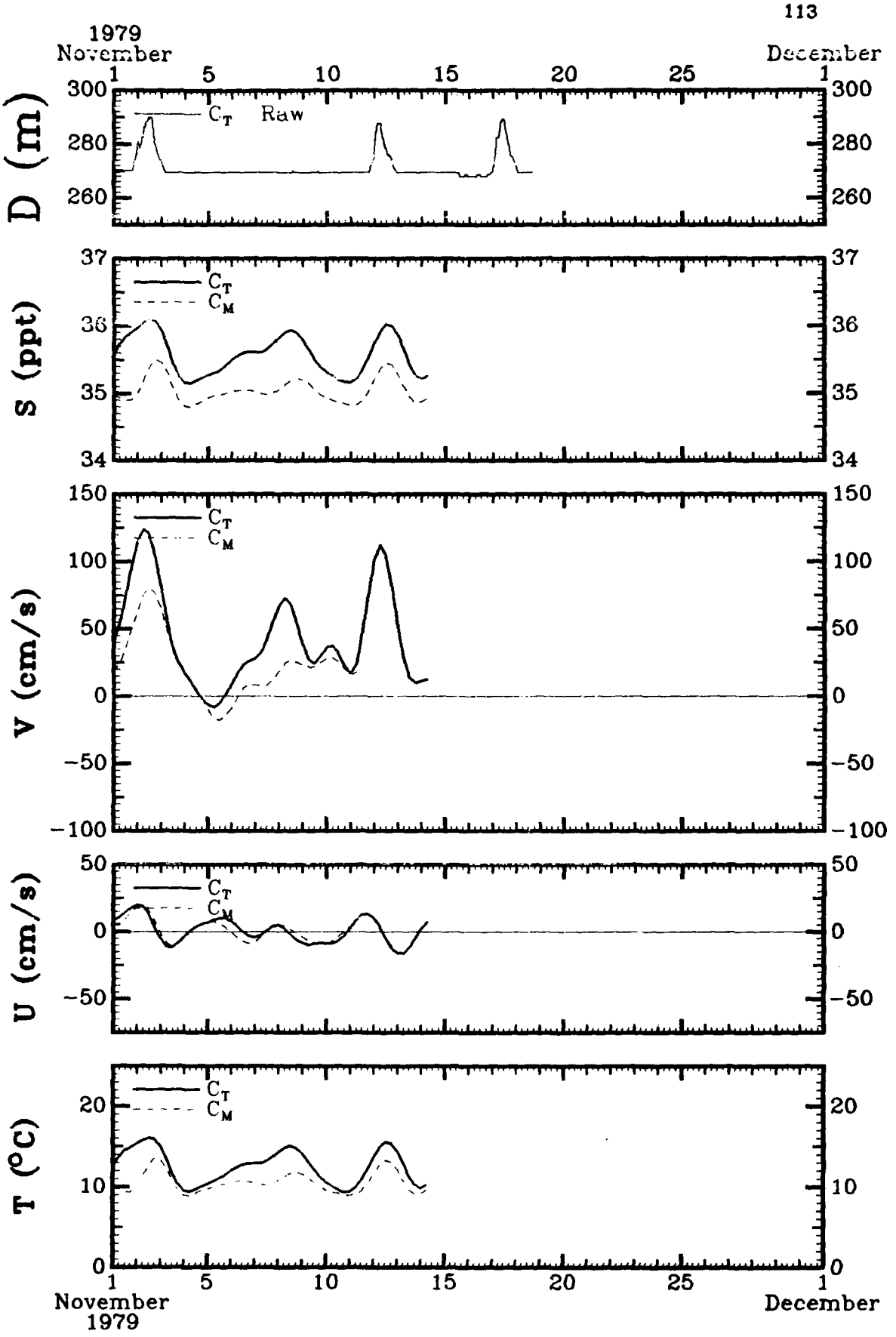

1979
October
November
1
5
10
15
20
25
30
1
D (m)
300
280
260
B_T Raw
S (ppt)
37
36
35
34
B_T
B_B
V (cm/s)
150
100
50
0
−50
−100
U (cm/s)
T (°C)
20
10
0
October
1979
November
Date/Time

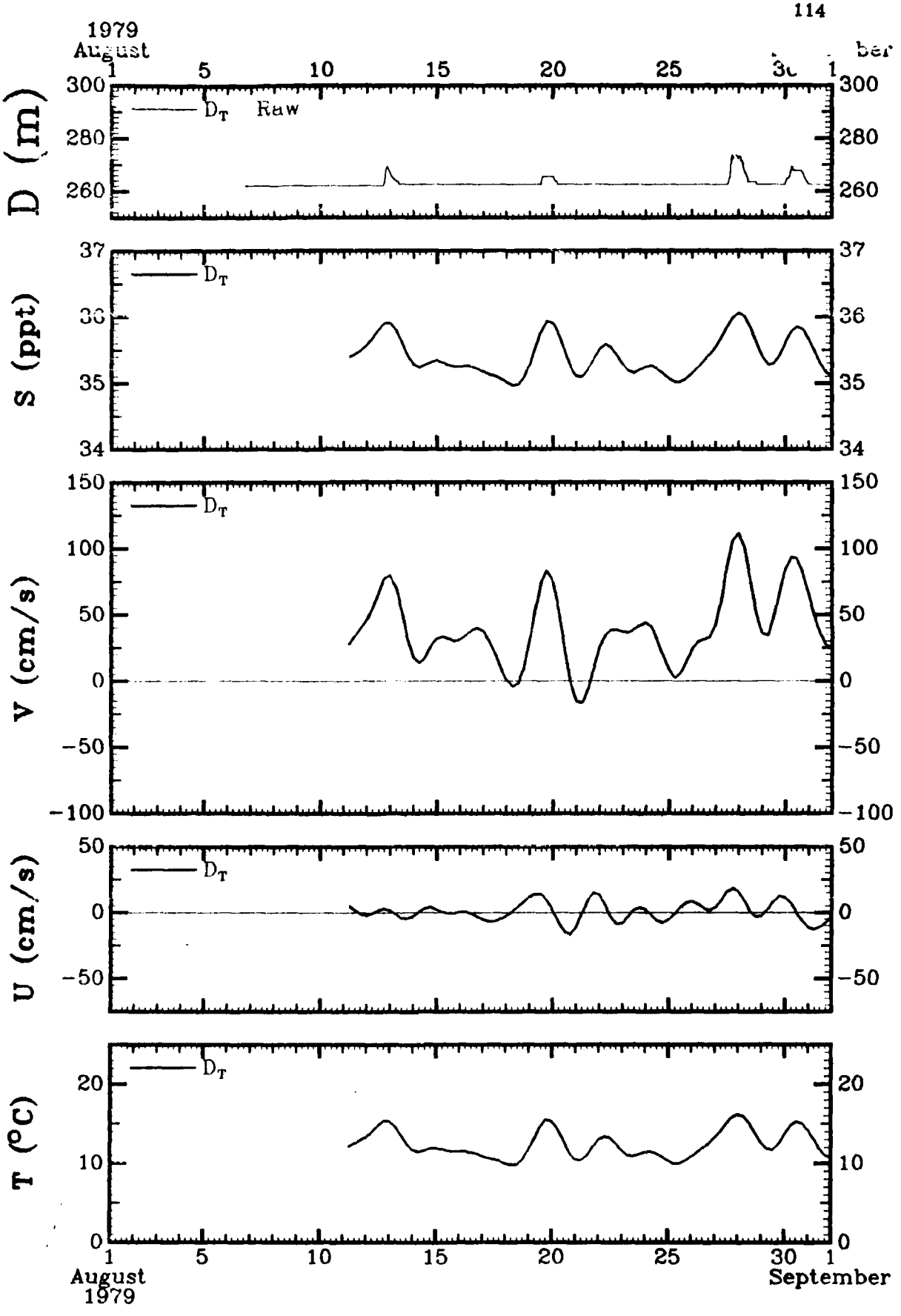

1979
November
December
1
5
10
15
20
25
1
D (m)
300
280
260
B_T Raw
S (ppt)
37
36
35
34
B_T
B_B
V (cm/s)
150
100
50
0
−50
−100
U (cm/s)
50
0
−50
T (°C)
20
10
0
November
1979
December
Date/Time

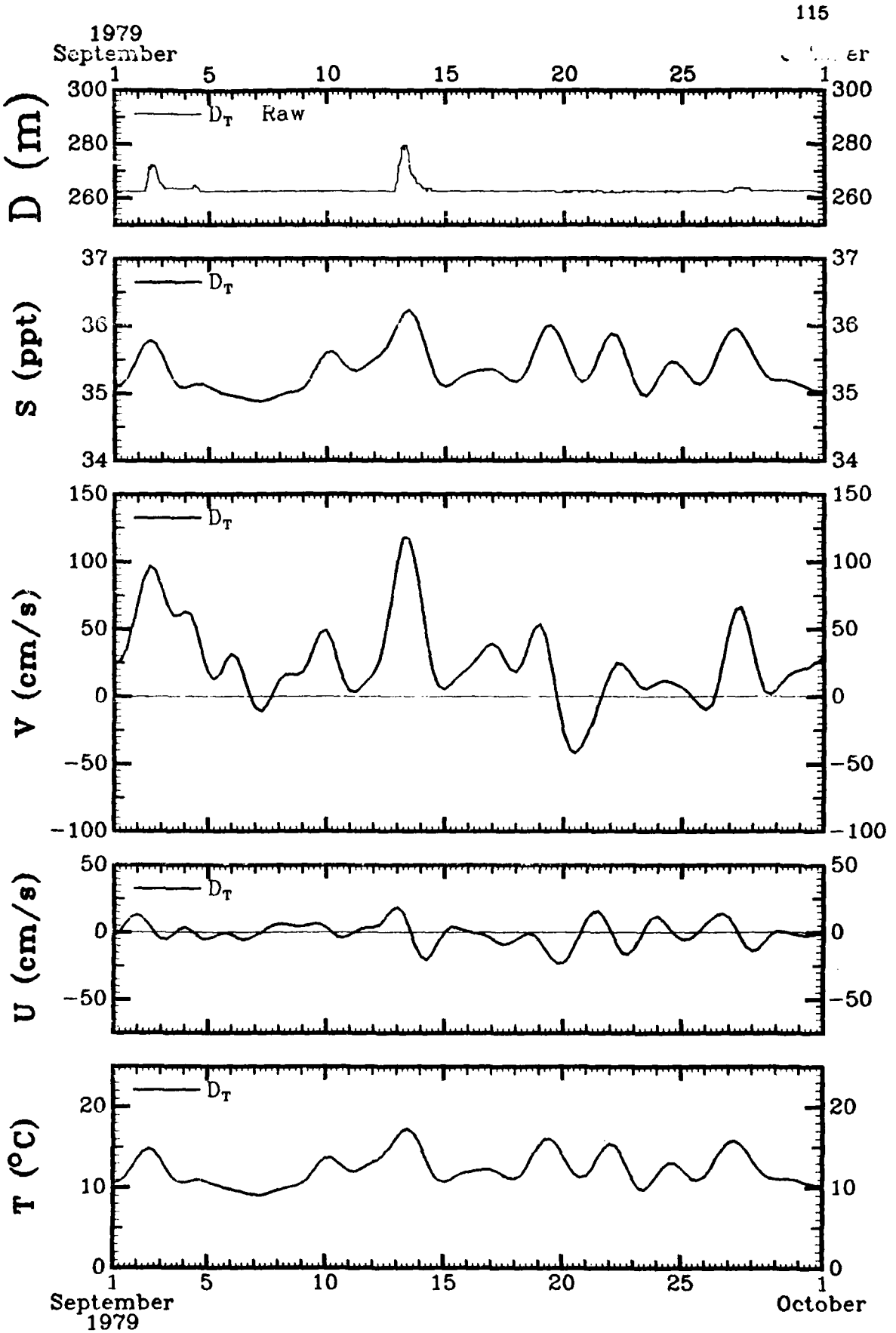

1979
August
September
1
5
10
15
20
25
30
1
D (m)
300
280
260
C_T Raw
S (ppt)
37
36
35
34
C_T
C_M
C_B
V (cm/s)
150
100
50
0
−50
−100
U (cm/s)
T (°C)
20
10
0
August
1979
September
Date/Time

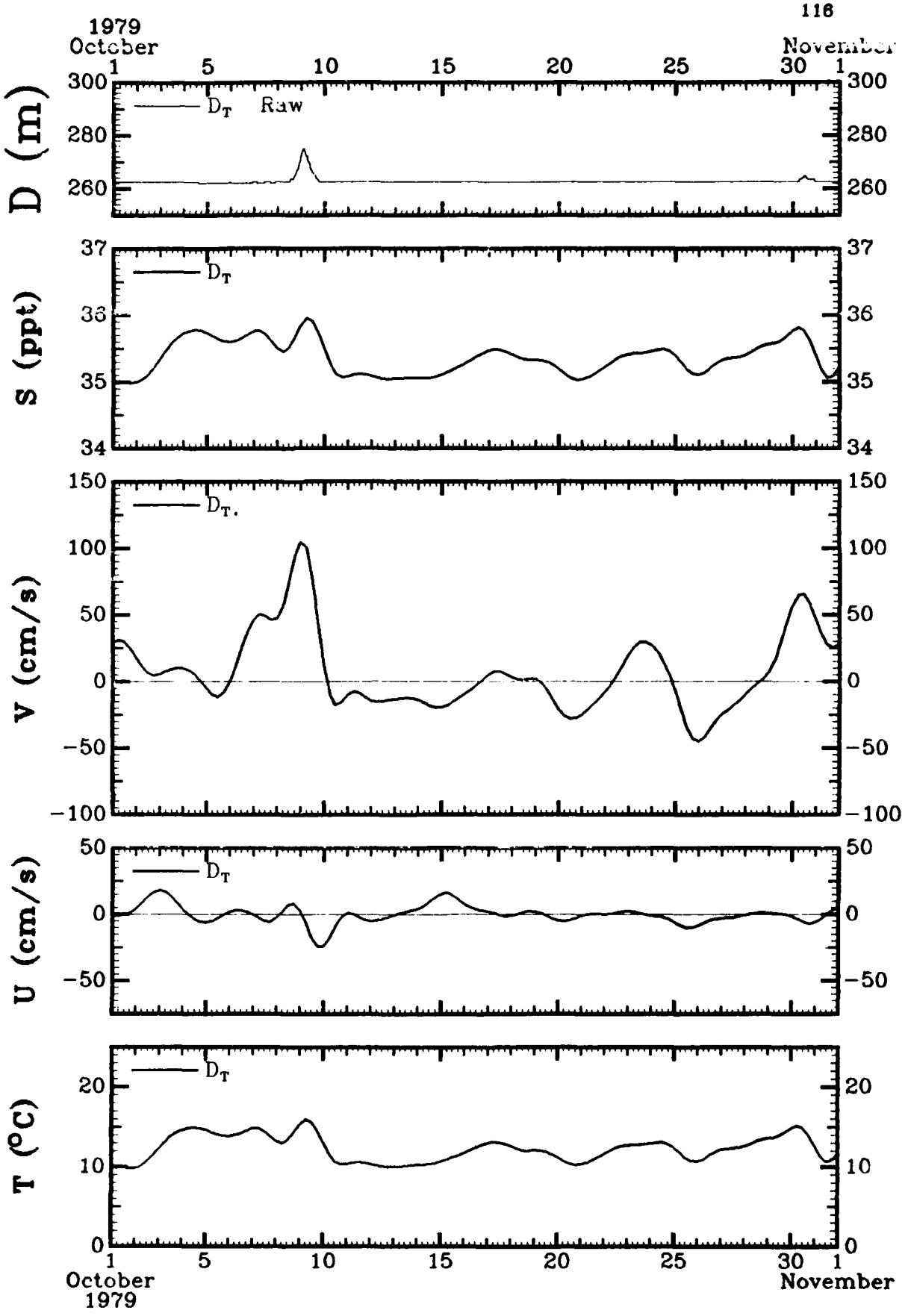

1979
September
October
1
5
10
15
20
25
1
D (m)
300
280
260
C_T Raw
S (ppt)
37
36
35
34
C_T
C_M
C_B
V (cm/s)
150
100
50
0
−50
−100
U (cm/s)
T (°C)
20
10
0
September
1979
October
Date/Time

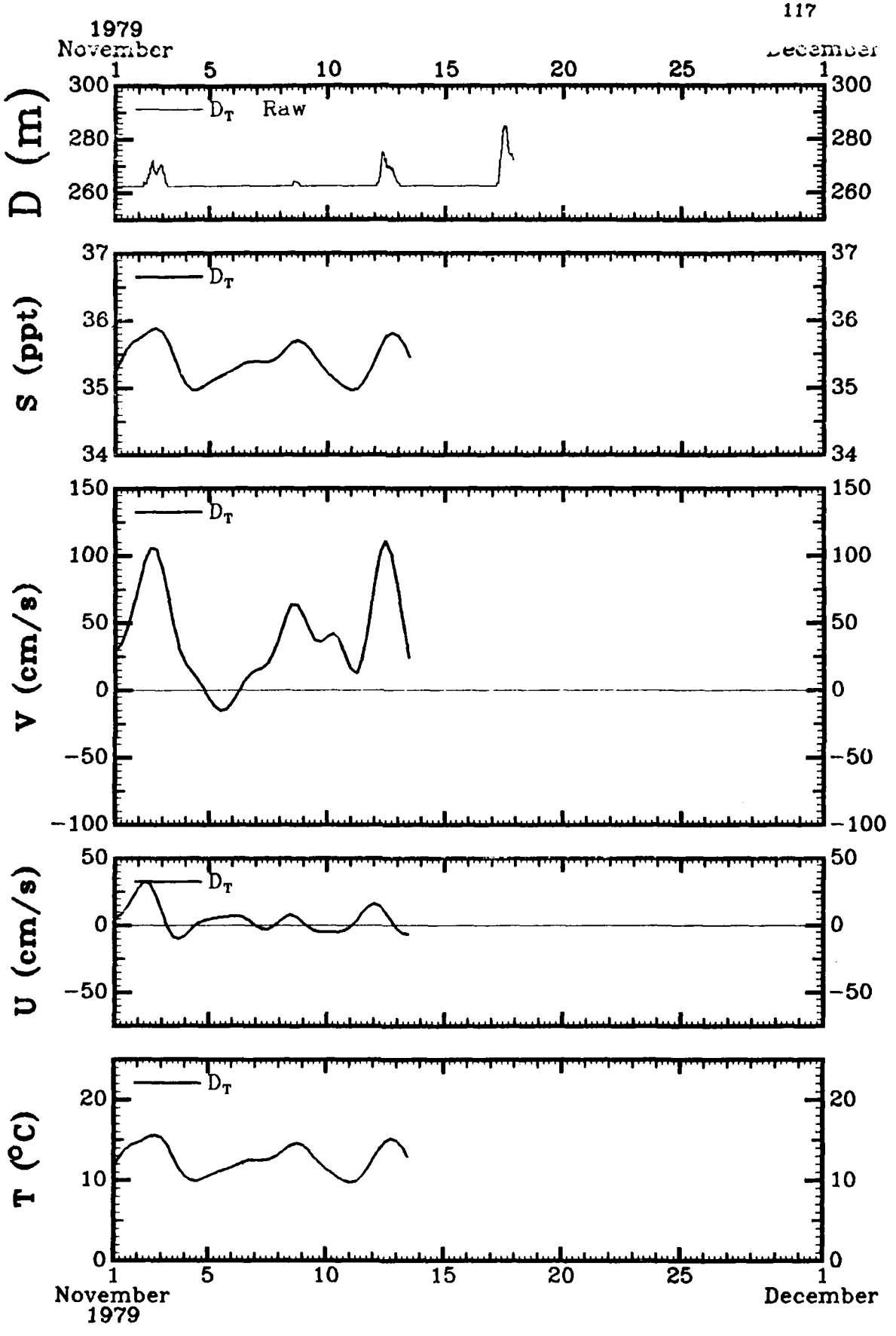

1979
October
November
1
5
10
15
20
25
30
D (m)
300
280
260
C_T Raw
S (ppt)
37
36
35
34
C_T
C_M
C_B
V (cm/s)
150
100
50
0
−50
−100
U (cm/s)
T (°C)
20
10
0
October
1979
November
Date/Time


1979
November
December
1
5
10
15
20
25
1
D (m)
300
280
260
C_T Raw
S (ppt)
37
36
35
34
C_T
C_M
V (cm/s)
150
100
50
0
−50
−100
U (cm/s)
50
0
−50
T (°C)
20
10
0
November
1979
December
Date/Time


1979
August
1
5
10
15
20
25
30
1
September
D (m)
300
280
260
D_T Raw
S (ppt)
37
36
35
34
D_T
V (cm/s)
150
100
50
0
−50
−100
D_T
U (cm/s)
50
0
−50
D_T
T (°C)
20
10
0
D_T
August
1979
Date/Time


1979
September
1
5
10
15
20
25
1
October
D (m)
300
280
260
D_T Raw
S (ppt)
37
36
35
34
D_T
V (cm/s)
150
100
50
0
−50
−100
D_T
U (cm/s)
50
0
−50
D_T
T (°C)
20
10
0
D_T
September
1979
October
Date/Time

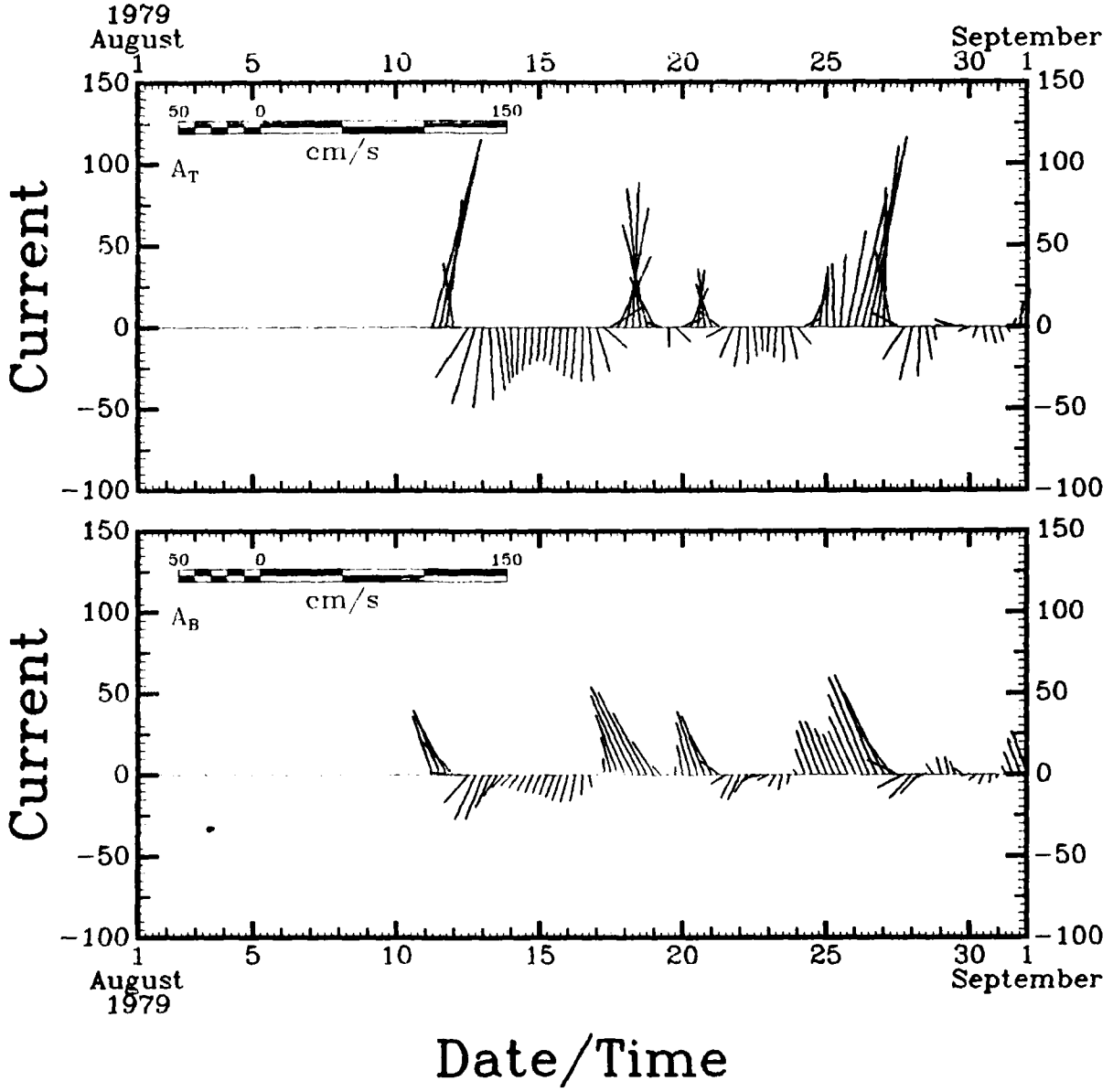

1979
October
November
1
5
10
15
20
25
30
1
D (m)
300
280
260
D_T Raw
S (ppt)
37
36
35
34
D_T
V (cm/s)
150
100
50
0
−50
−100
D_T.
U (cm/s)
D_T
T (°C)
20
10
0
D_T
October
1979
November
Date/Time

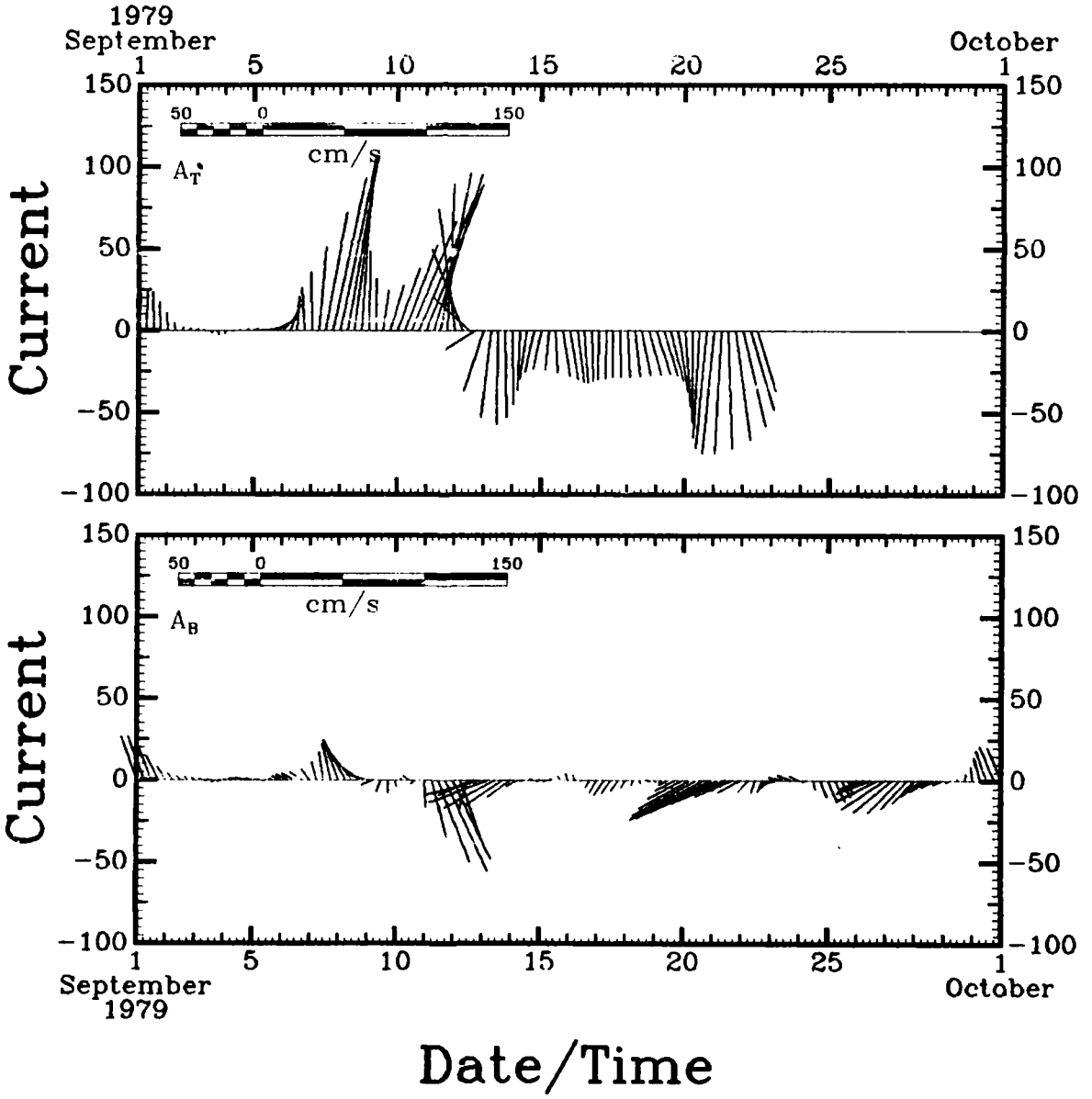

1979
November
December
1
5
10
15
20
25
1
D (m)
300
280
260
D_T Raw
S (ppt)
37
36
35
34
D_T
V (cm/s)
150
100
50
0
−50
−100
D_T
U (cm/s)
50
0
−50
D_T
T (°C)
20
10
0
D_T
1
November
1979
December
Date/Time

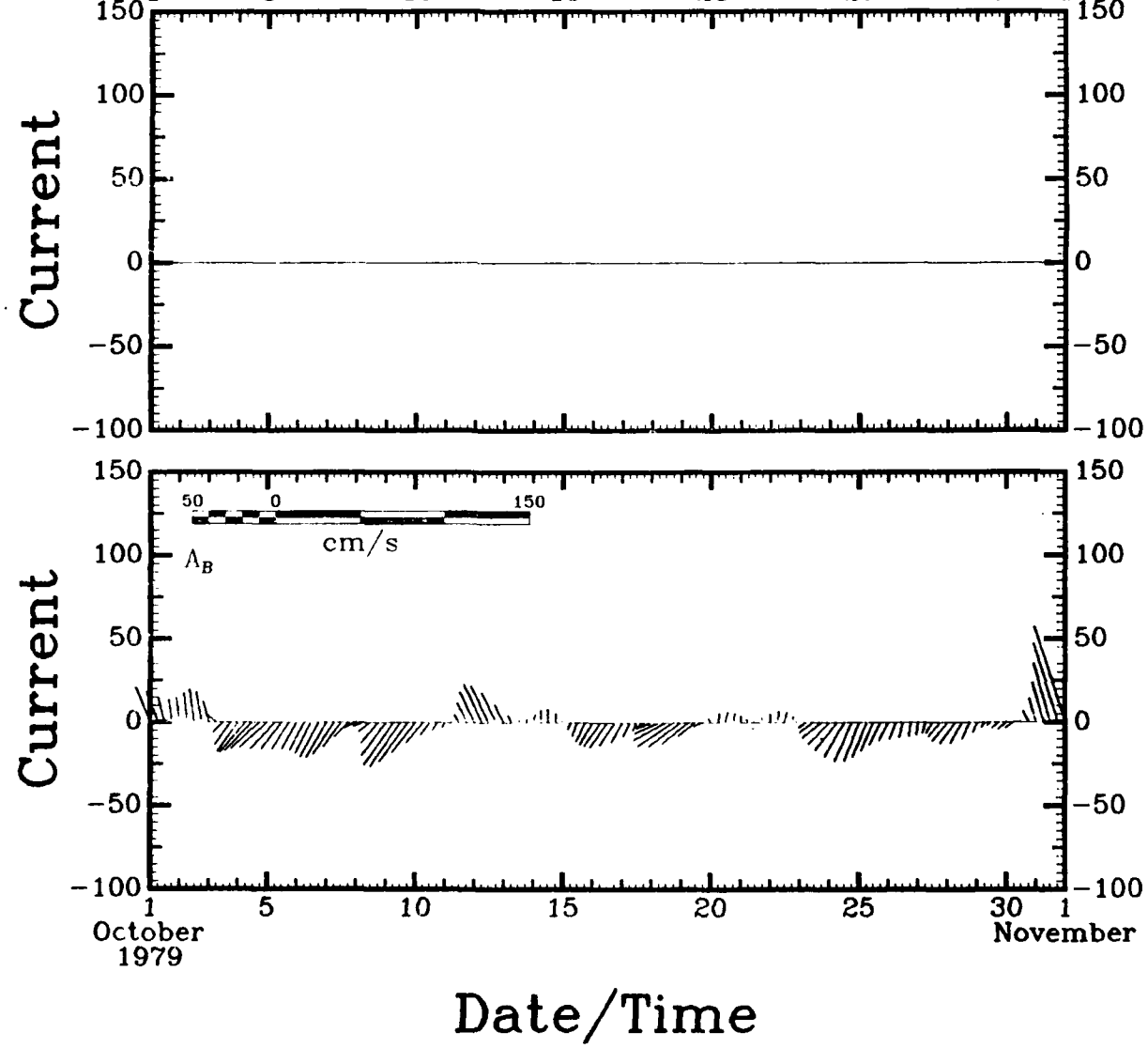
SECTION 6

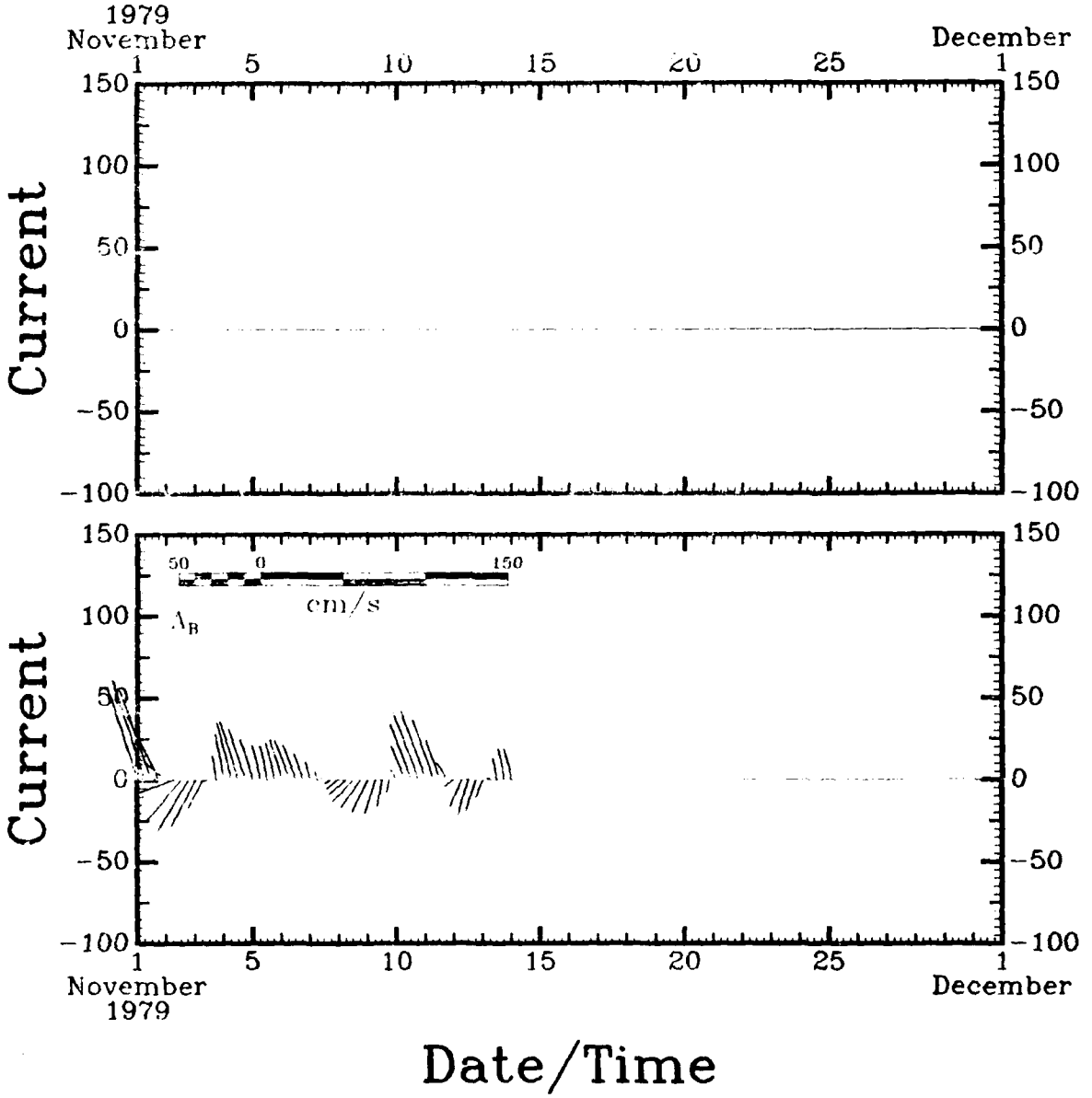
40 HRLP Current Vector "Stick" Plots for Each Mooring

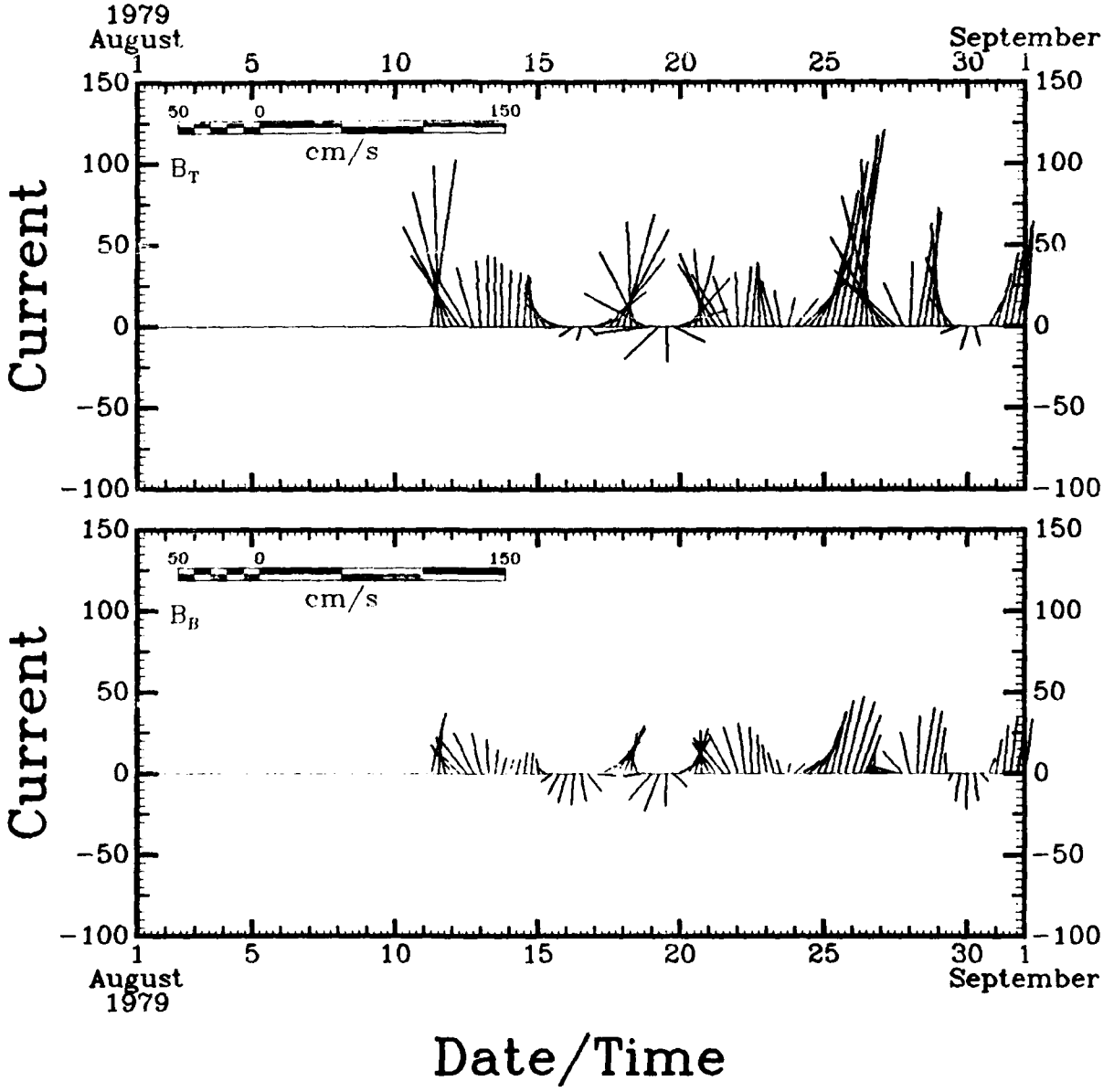
Figures 35 through 38 show the 40 HRLP current vectors in "stick" format by month for each mooring. Vectors pointing toward the top of the page correspond to flow in the downstream (34°T) direction. Common scaling is used in this section.

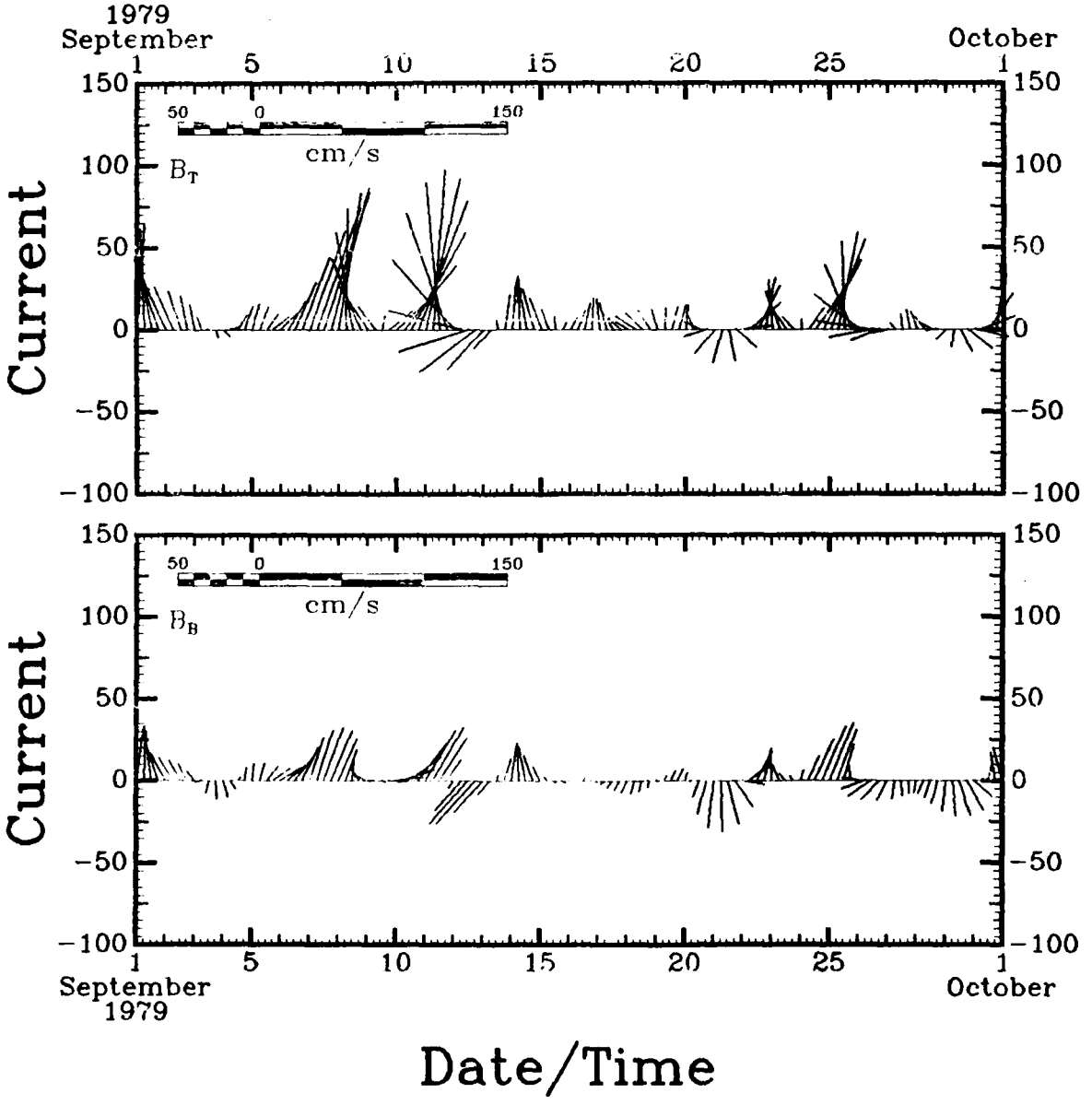

1979
August
September
1
5
10
15
20
25
30
1
150
100
50
0
−50
−100
50
0
150
cm/s
A_T
A_B
Current
Current
August
1979
September
Date/Time

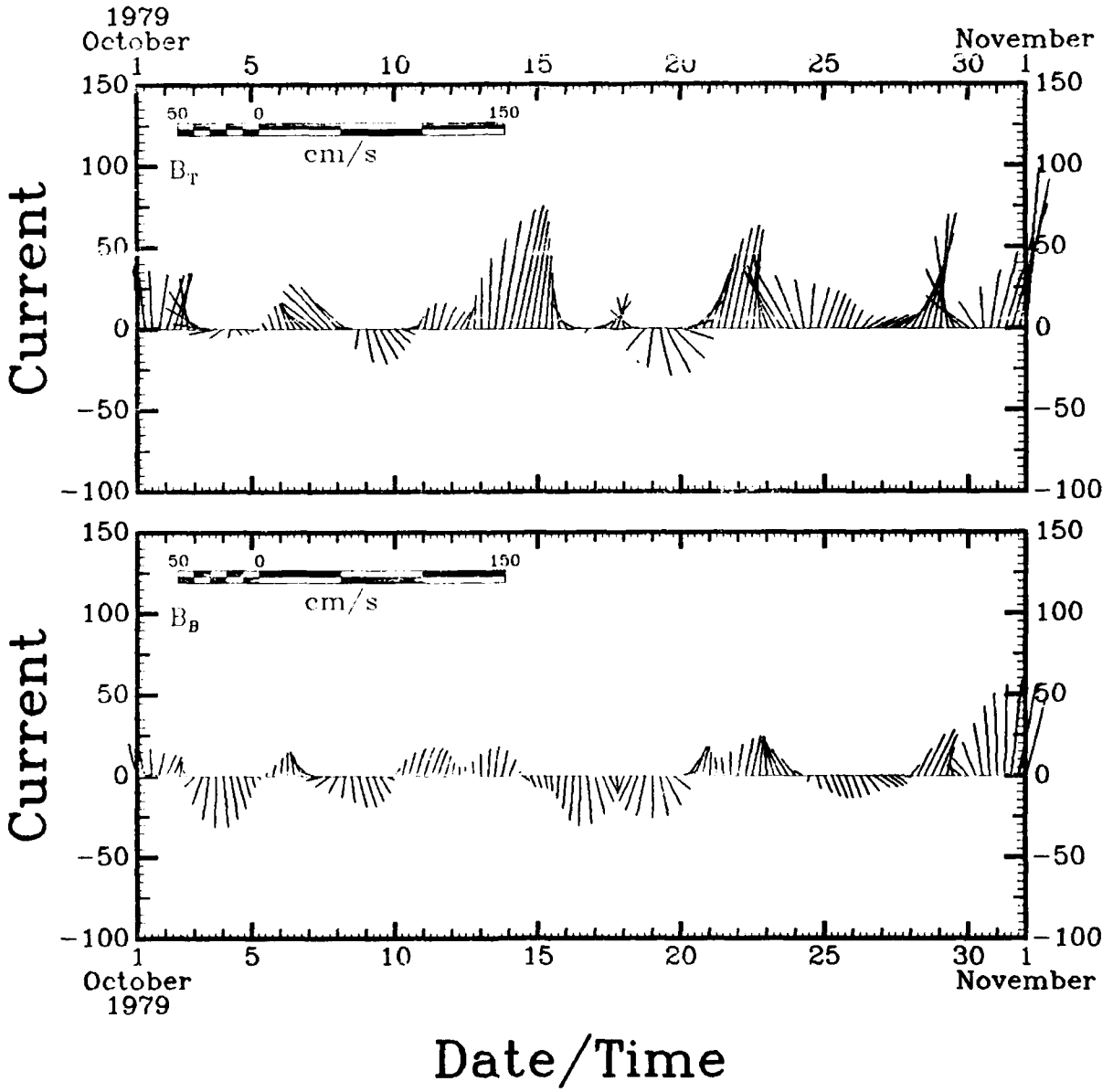

1979
September
October
1
5
10
15
20
25
1
150
100
50
0
−50
−100
50
0
150
cm/s
A_T
A_B
Current
Current
September
1979
October
Date/Time

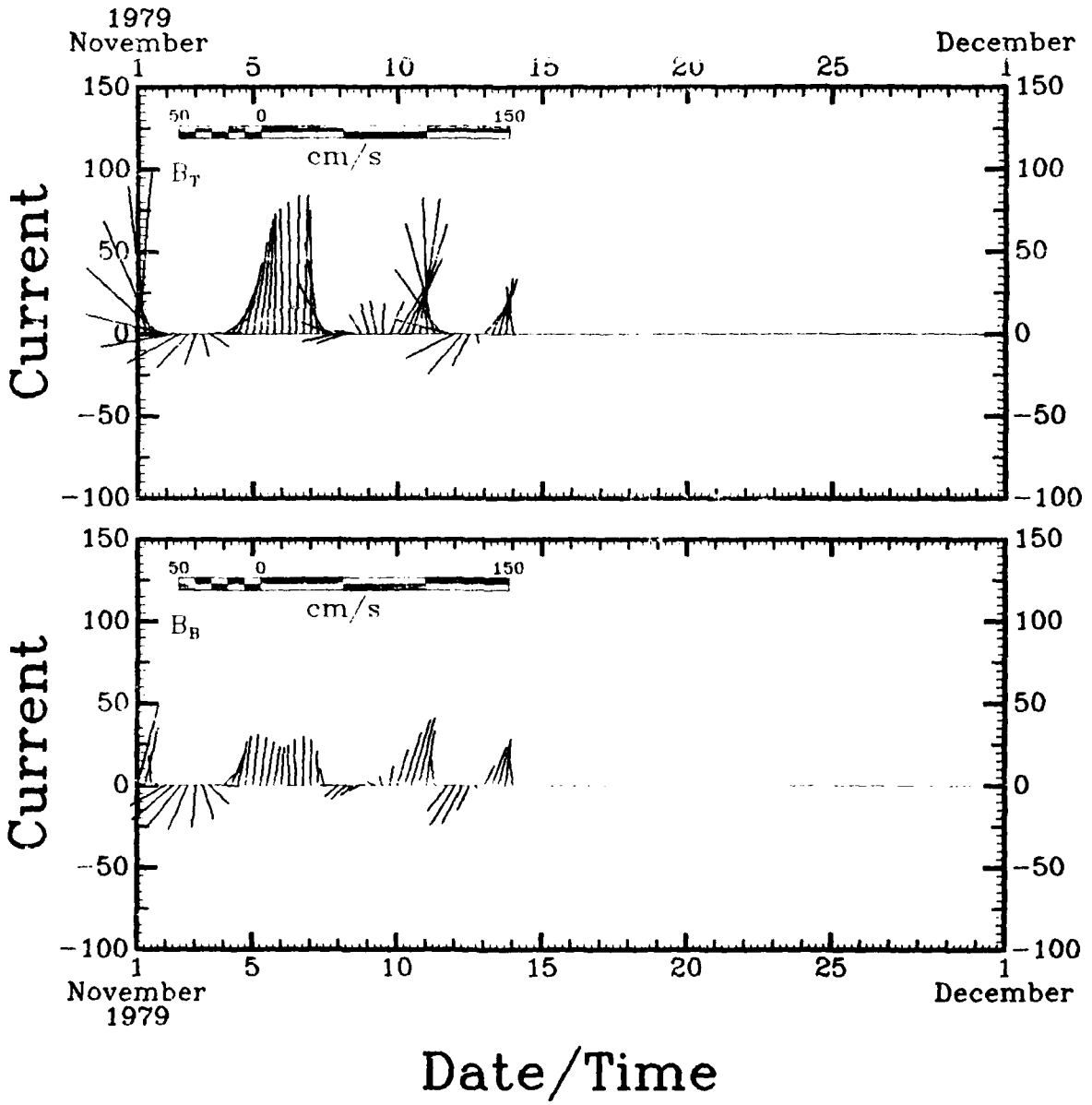

1979
October
November
1
5
10
15
20
25
30
1
150
100
50
0
−50
−100
Current
50
0
150
cm/s
A_B
Current
October
1979
November
Date/Time

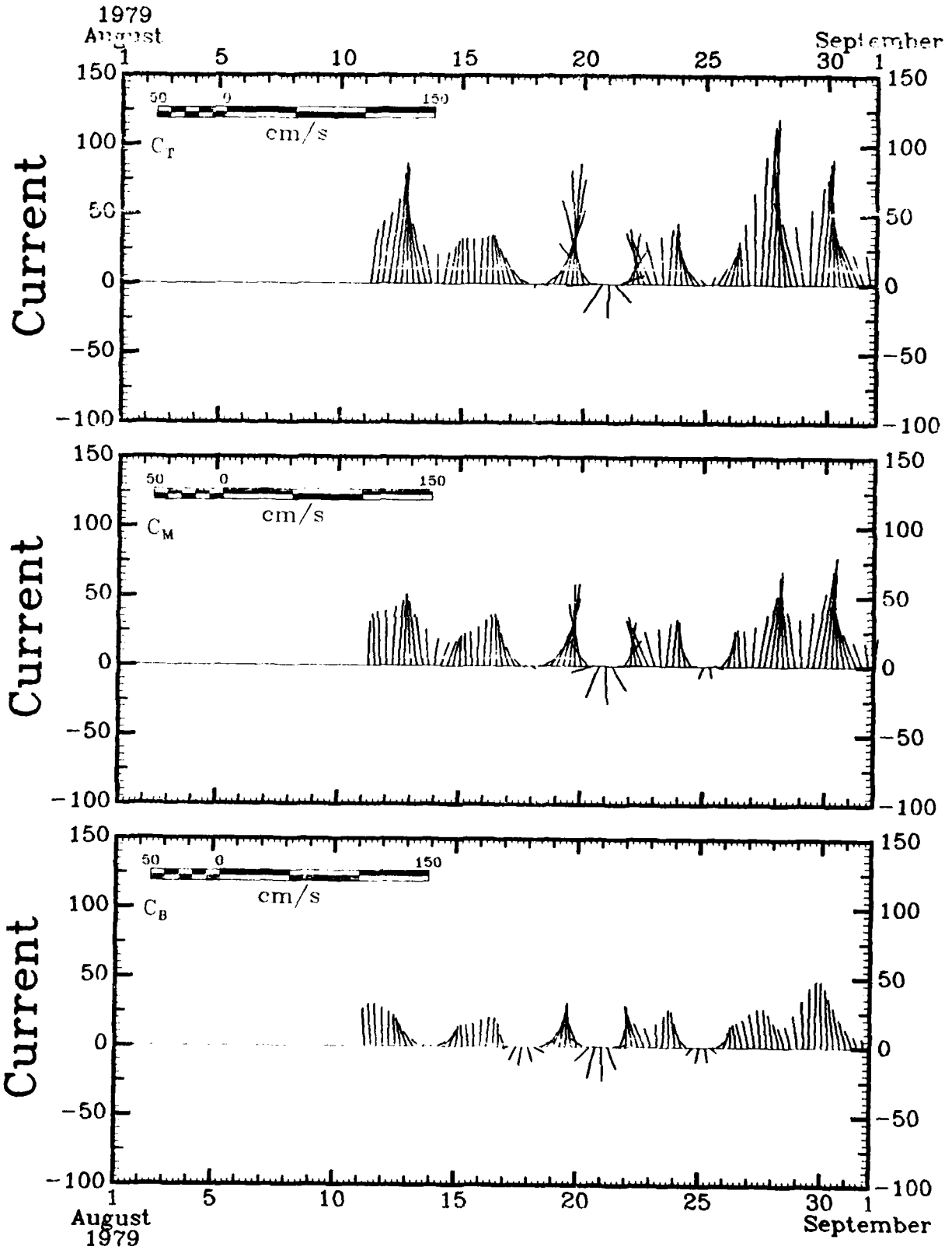

1979
November
December
1
5
10
15
20
25
1
150
100
50
0
−50
−100
Current
50
0
150
cm/s
A_B
Current
1
November
1979
Date/Time

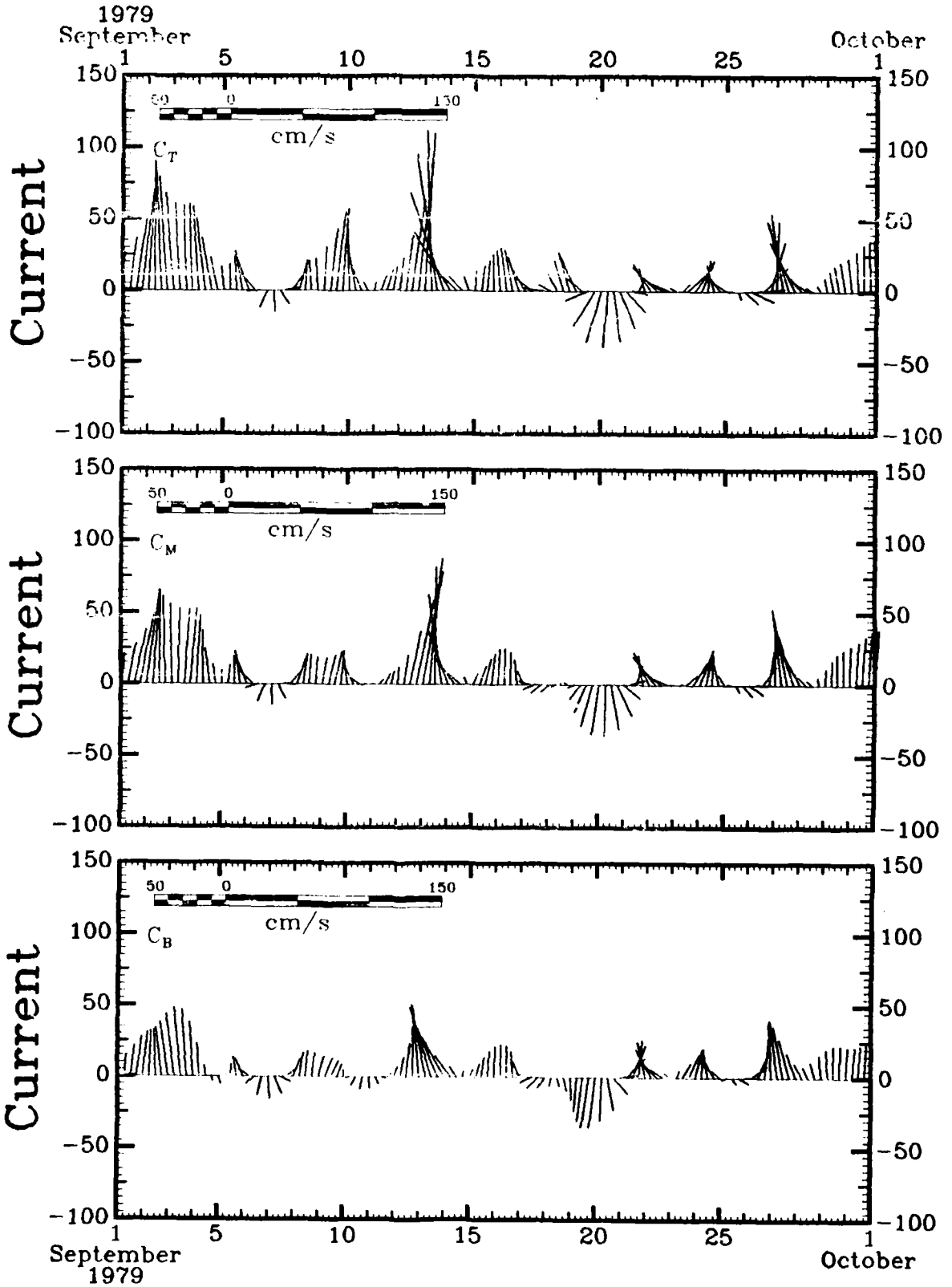

1979
August
September
1
5
10
15
20
25
30
1
150
100
50
0
−50
−100
50
0
150
cm/s
B_T
B_B
Current
Current
August
1979
September
Date/Time

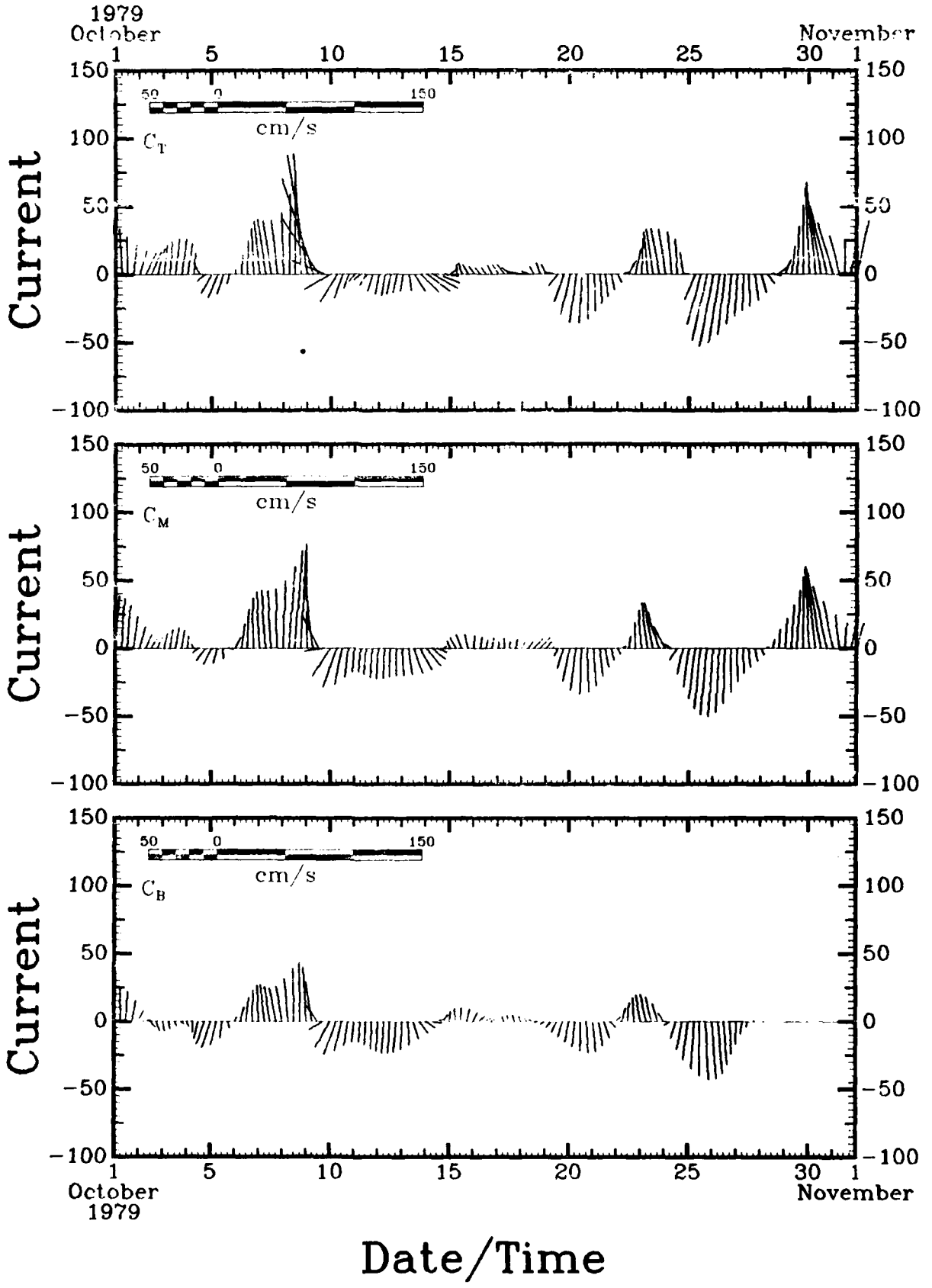

1979
September
October
1
5
10
15
20
25
1
150
100
50
0
−50
−100
50
0
150
cm/s
B_T
B_B
Current
Current
September
1979
October
Date/Time

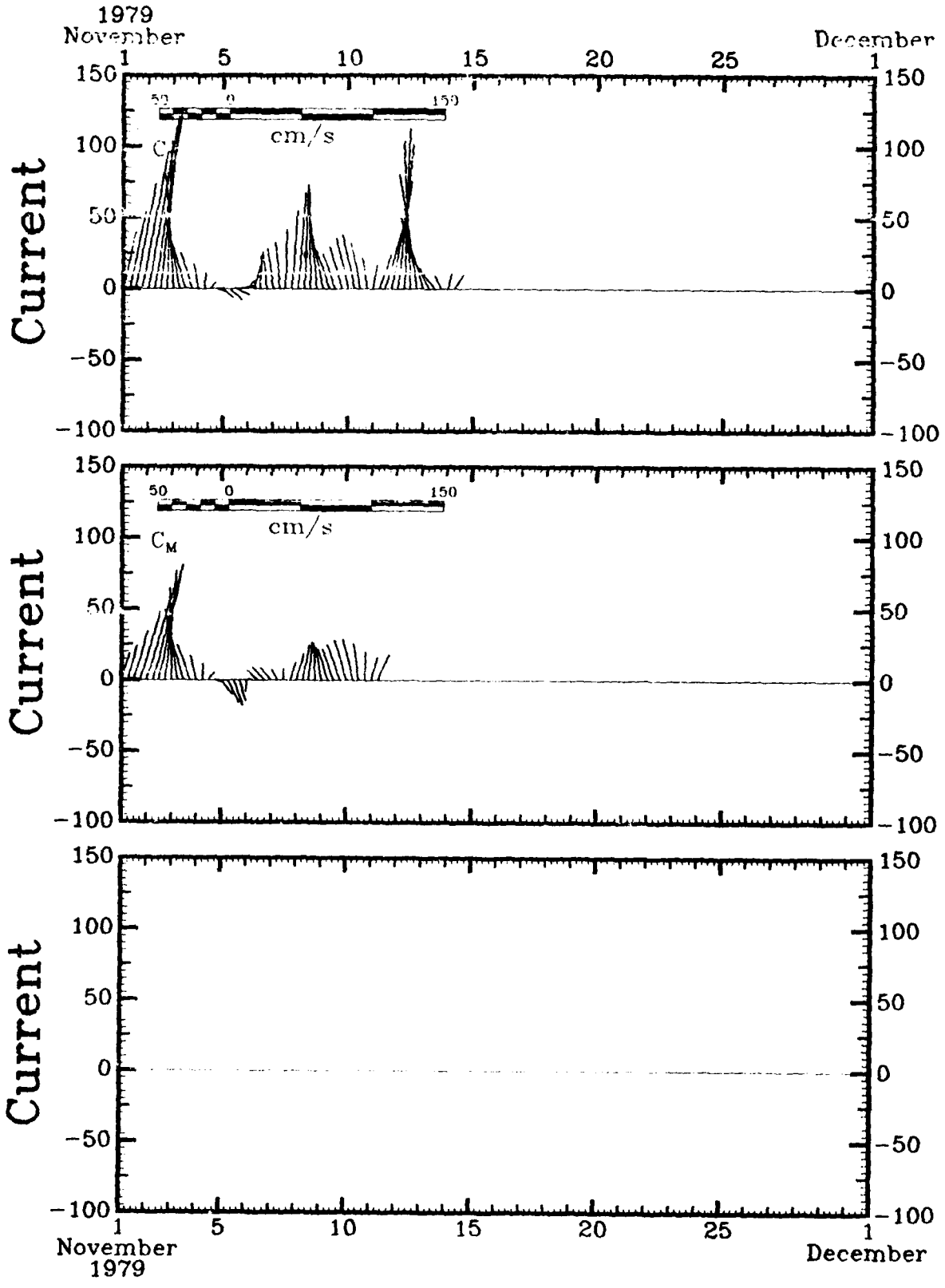

1979
October
November
1
5
10
15
20
25
30
1
150
100
50
0
−50
−100
50
0
150
cm/s
B_T
B_B
Current
Current
October
1979
November
Date/Time

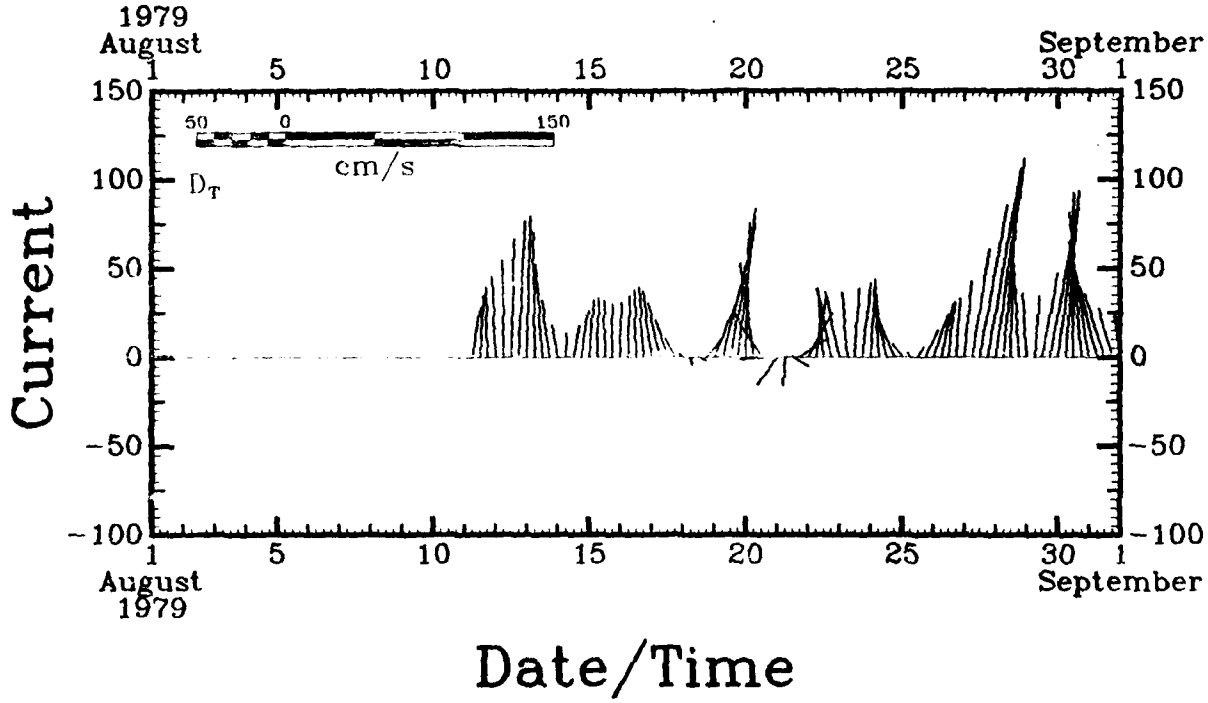

1979
November
December
1
5
10
15
20
25
1
150
100
50
0
−50
−100
50
0
150
cm/s
B_T
B_B
Current
Current
November
1979
December
Date/Time

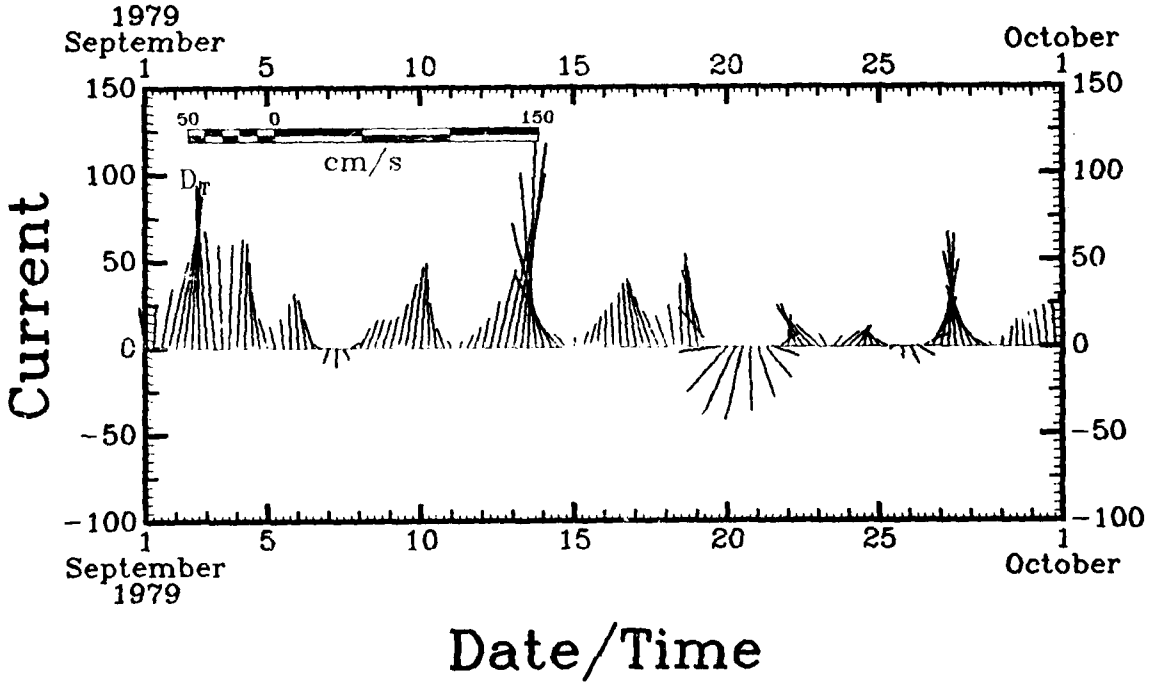

1979
August
September
1
5
10
15
20
25
30
1
150
100
50
0
−50
−100
50
0
150
cm/s
C_T
C_M
C_B
Current
1
August
1979
September
Date/Time

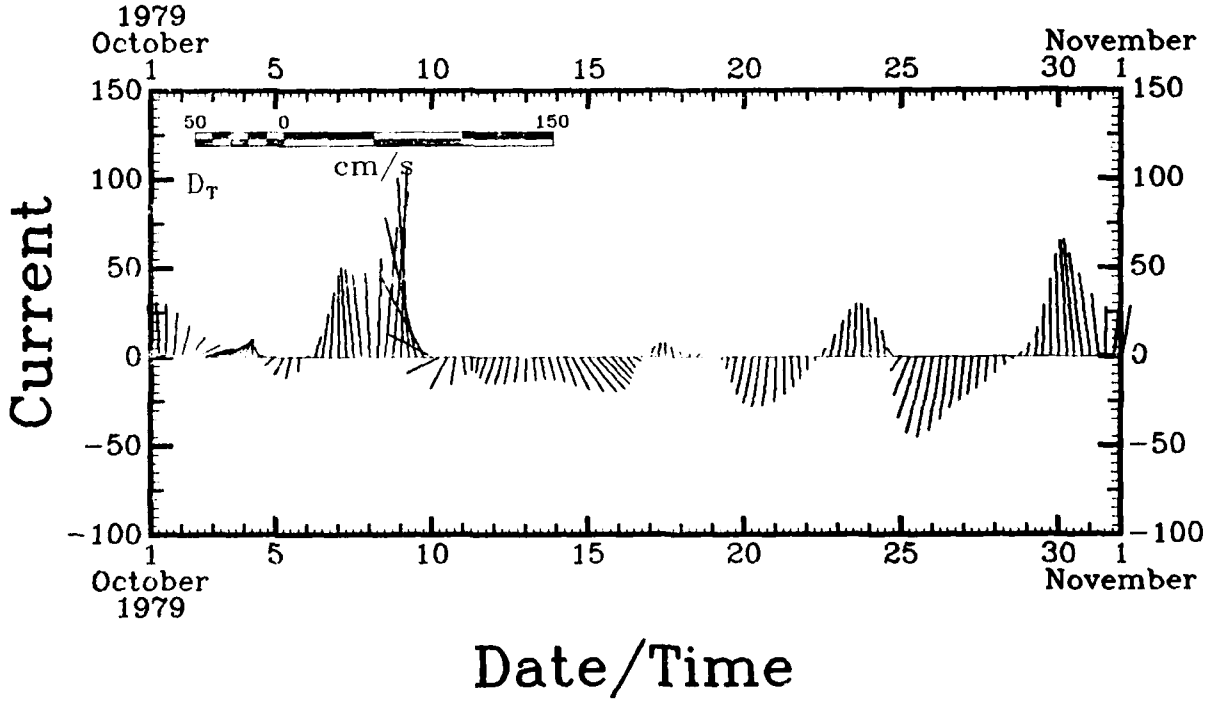

1979
September
October
1
5
10
15
20
25
1
150
100
50
0
-50
-100
50 0 150
cm/s
C_T
C_M
C_B
Current
Current
Current
September
1979
October
Date/Time

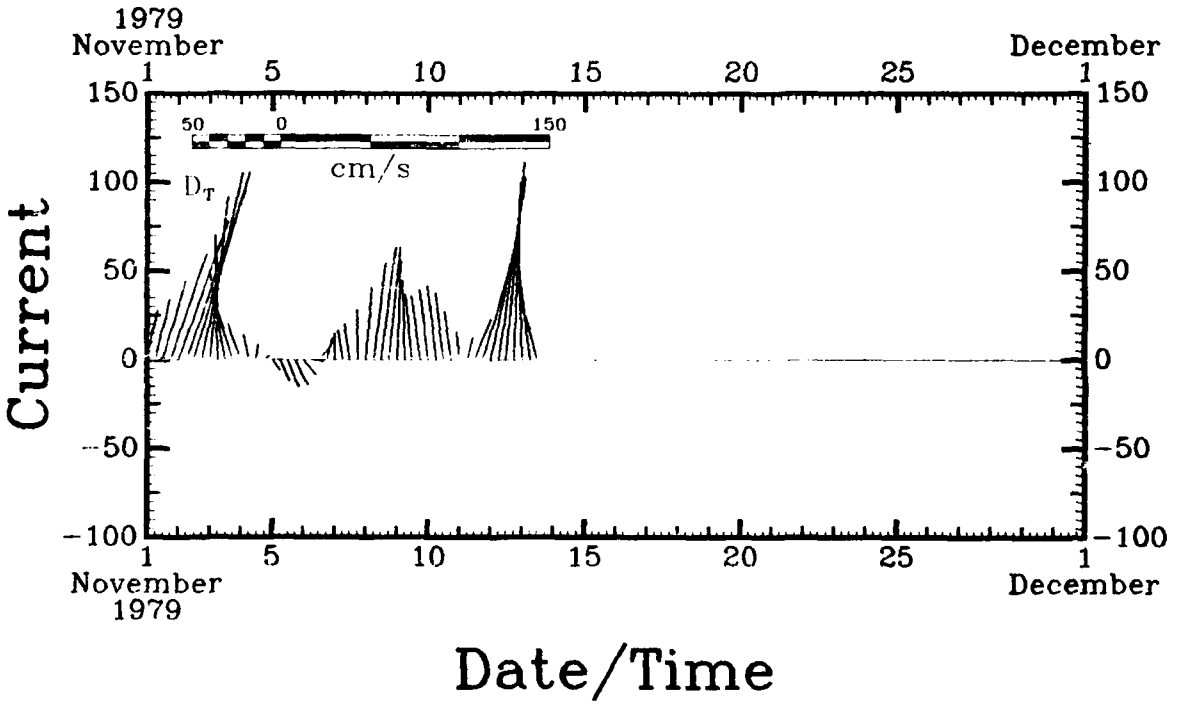

1979
October
November
1
5
10
15
20
25
30
1
150
100
50
0
−50
−100
50
0
150
cm/s
C_T
C_M
C_B
Current
Current
Current
October
1979
November
Date/Time


1979
November
December
1
5
10
15
20
25
1
150
100
50
0
−50
−100
50
0
150
cm/s
C_M
Current
Current
Current
November
1979
December
Date/Time


1979
August
September
1
5
10
15
20
25
30
1
150
100
50
0
−50
−100
50
0
150
cm/s
D_T
Current
August
1979
September
Date/Time


1979
September
October
1
5
10
15
20
25
1
150
100
50
0
−50
−100
50
0
150
cm/s
D_T
Current
1
September
1979
Date/Time

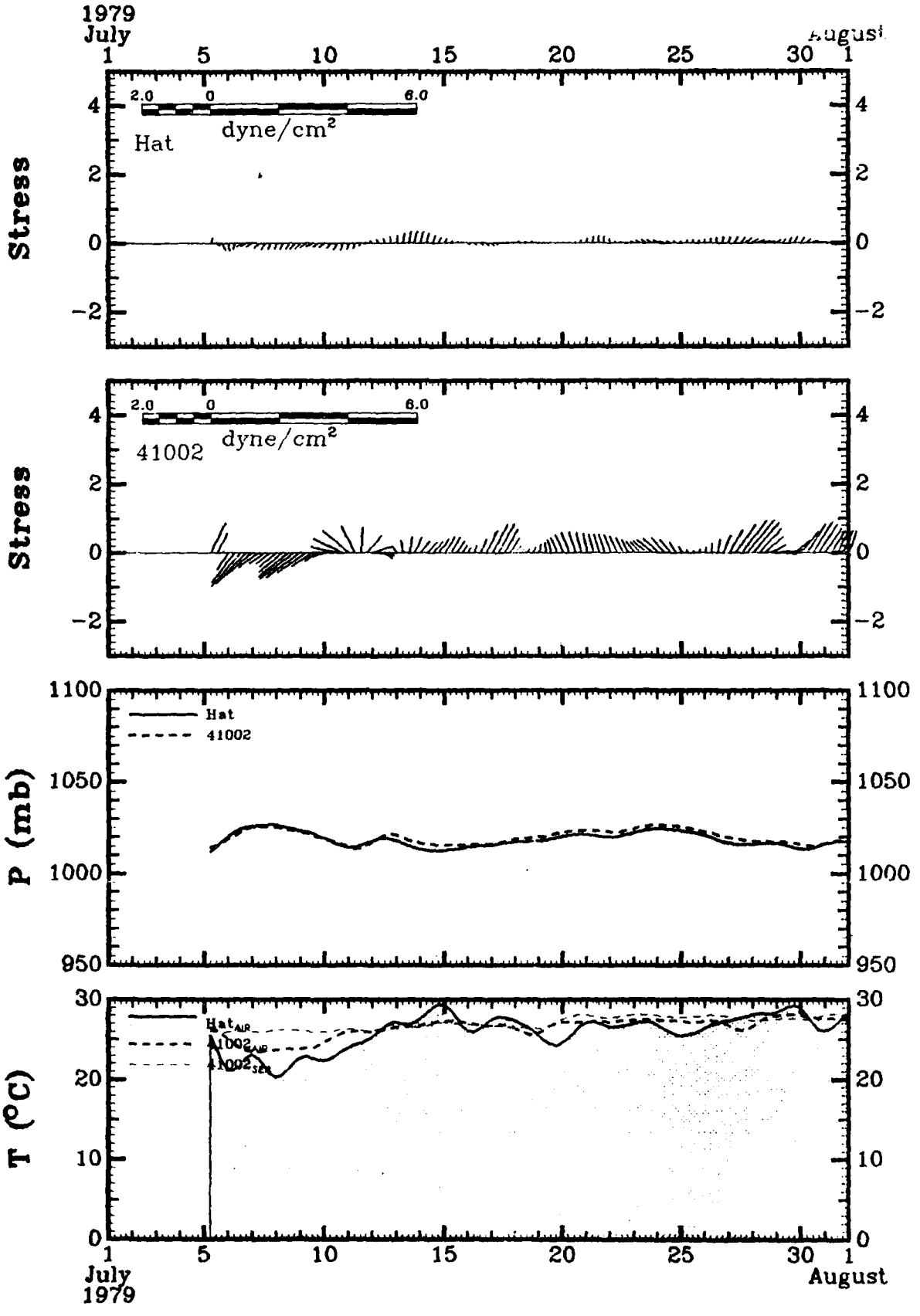

1979
October
November
1
5
10
15
20
25
30
1
150
100
50
0
−50
−100
50
0
150
cm/s
D_T
Current
October
1979
November
Date/Time

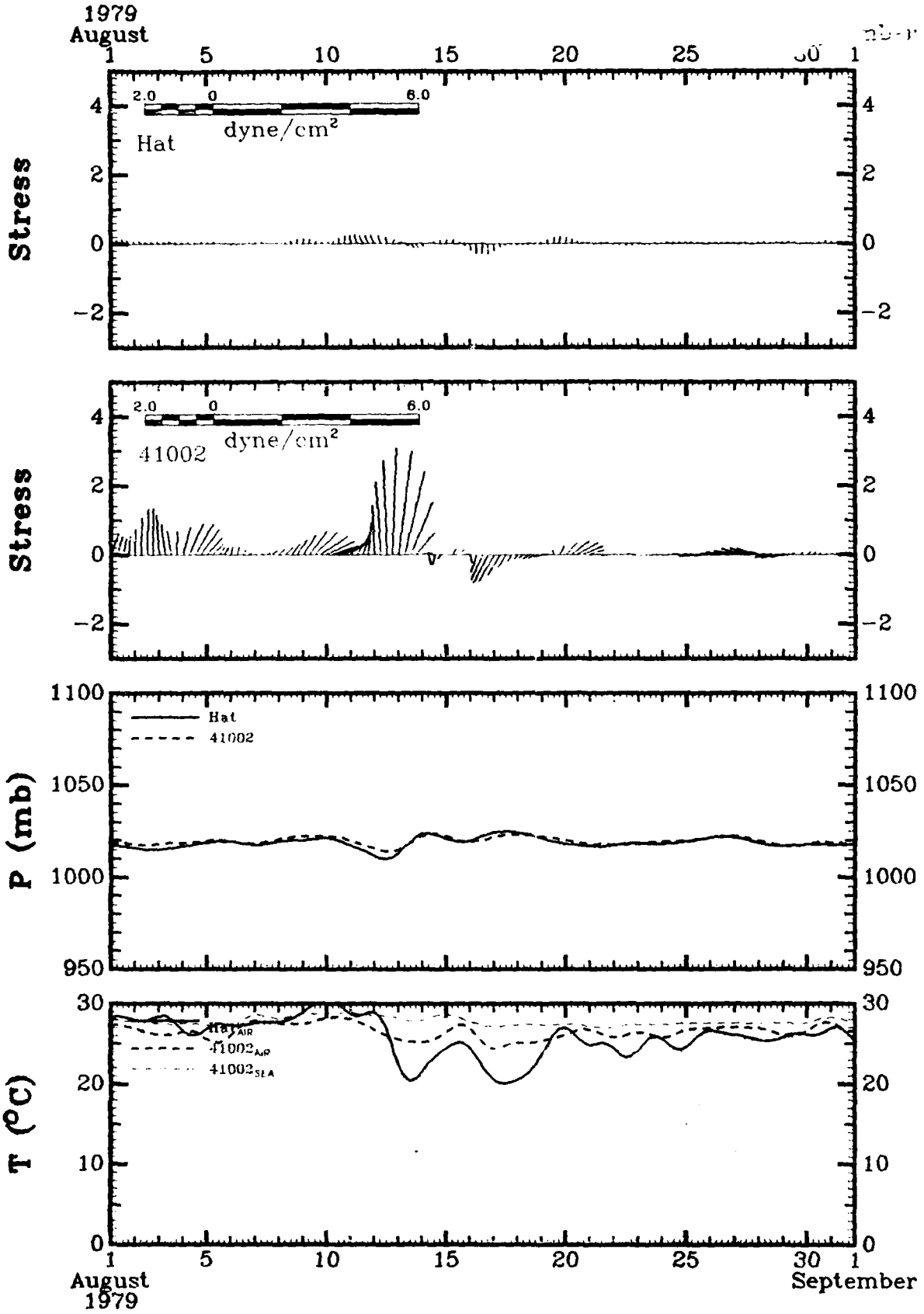

1979
November
December
1
5
10
15
20
25
1
150
100
50
0
−50
−100
50
0
150
cm/s
D_T
Current
1
November
1979
Date/Time

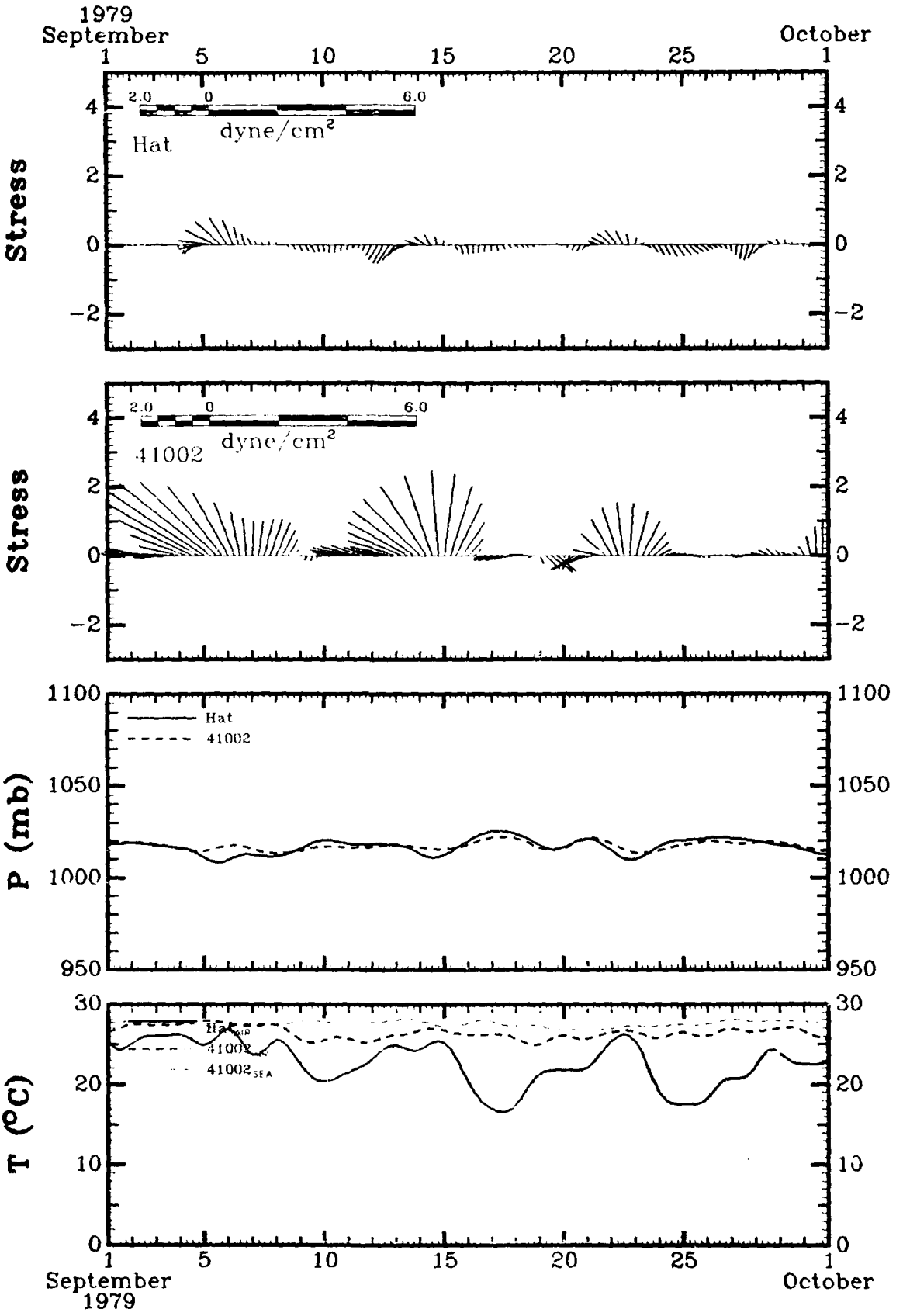
SECTION 7

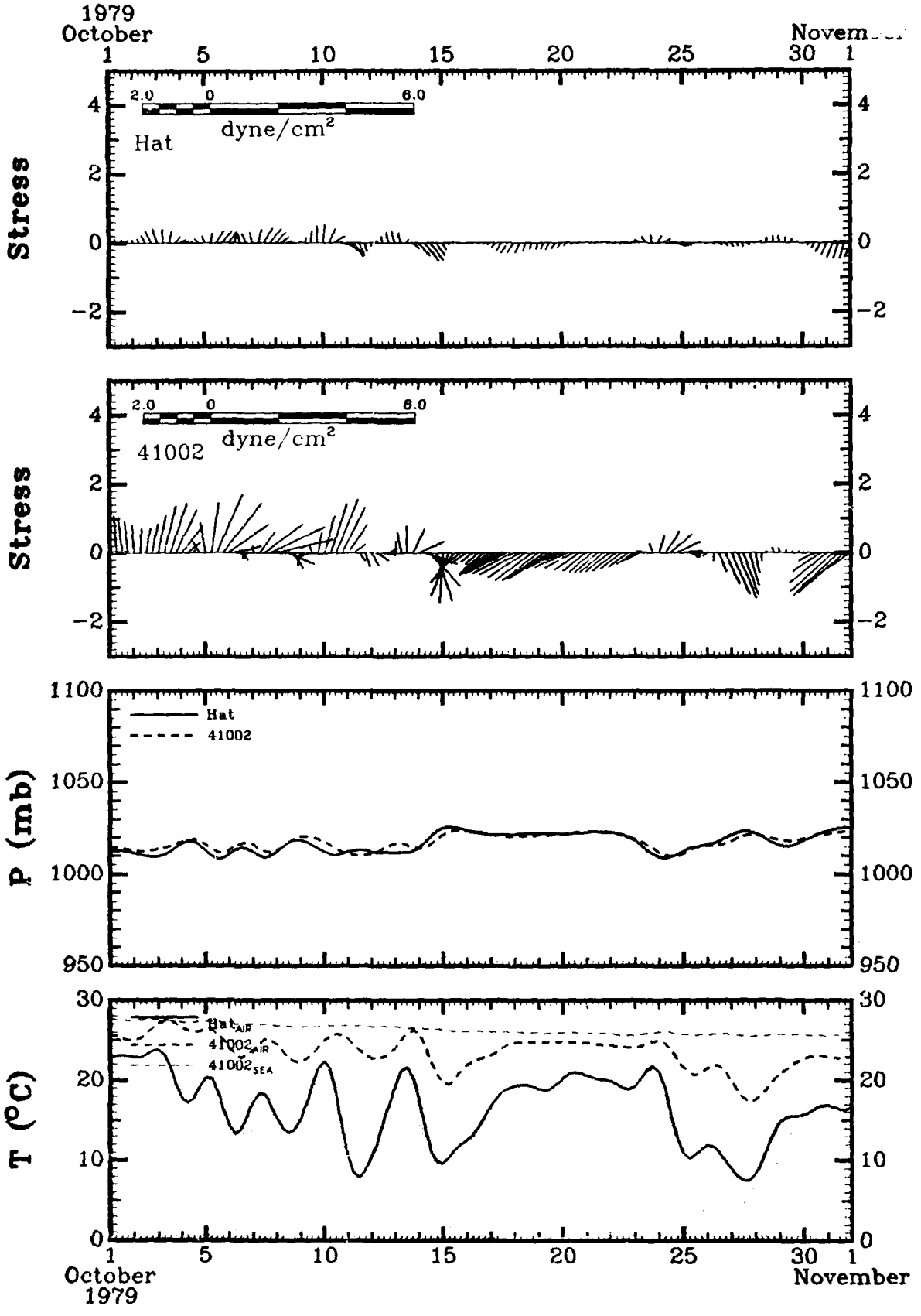
40 HRLP Atmospheric Data from Cape Hatteras and NDBO Buoy 41002

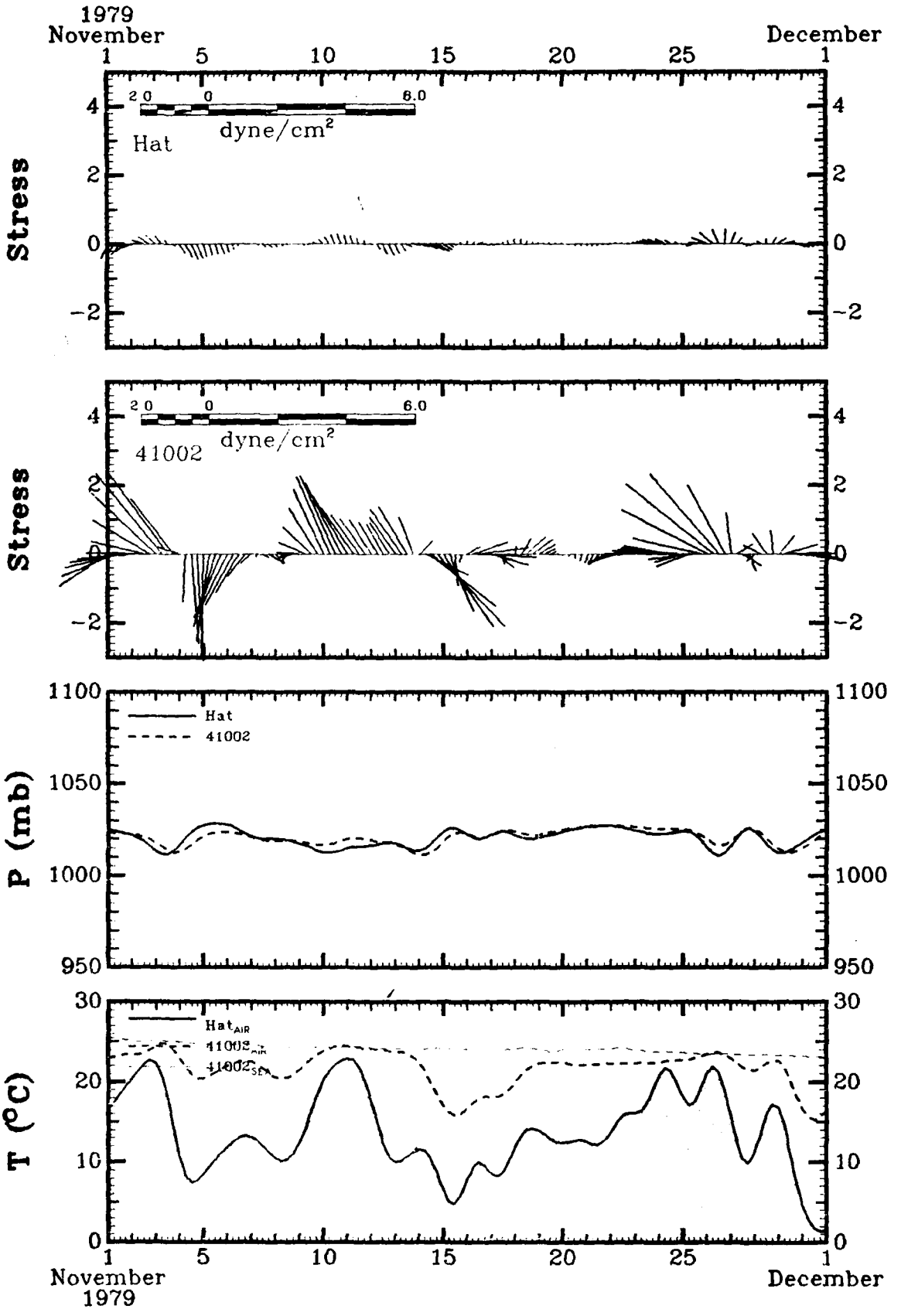
Figure 39 shows by month the 40 HRLP wind stress vector "sticks", the atmospheric pressure, and the air and sea temperatures at Cape Hatteras and the NDBO-2 buoy (see Fig. 1). Vectors pointing toward the top of the page correspond to flow in the downstream (34°T) direction. Common scaling is used in this section.

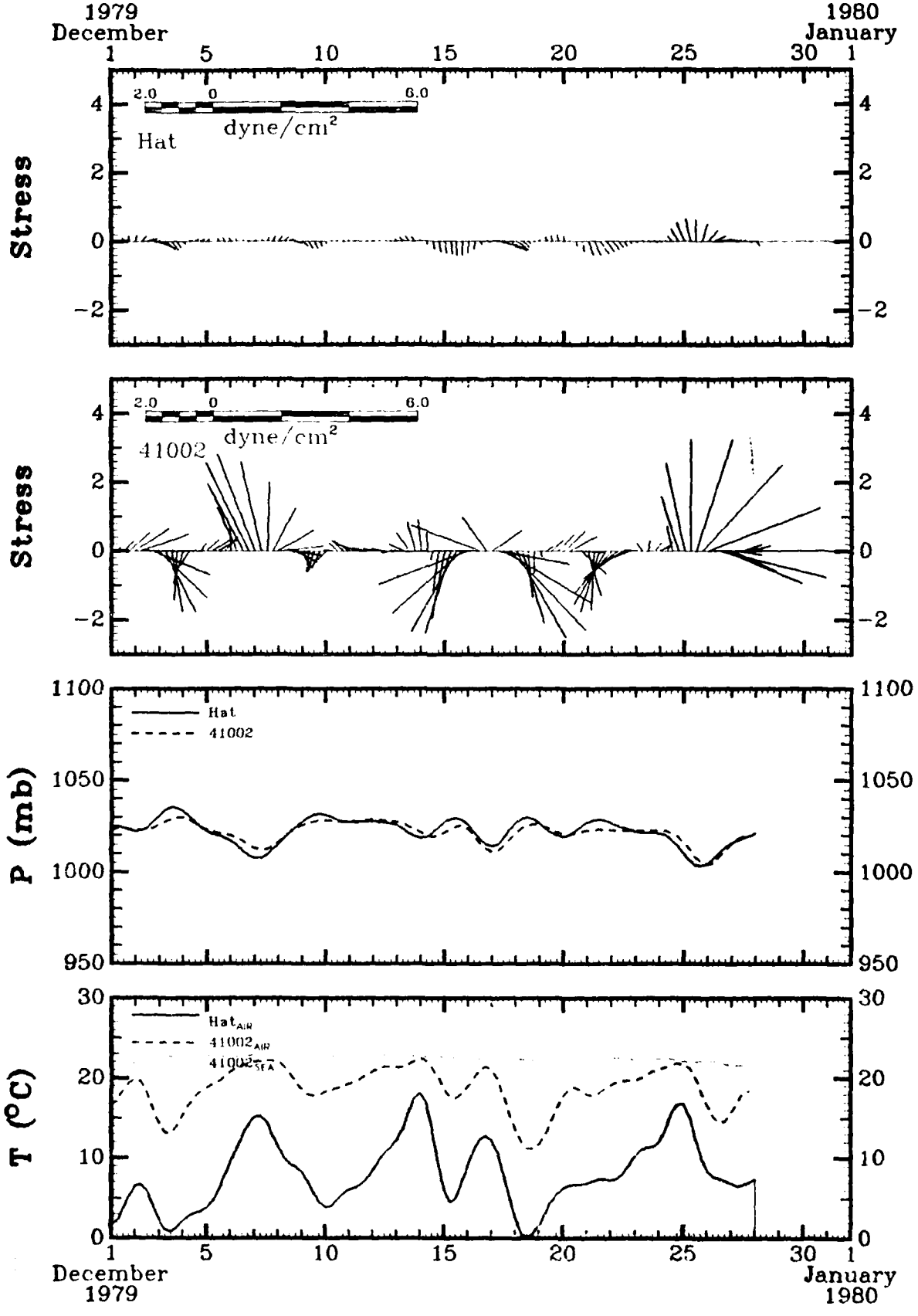

1979
July
August
1
5
10
15
20
25
30
1
Stress
2.0
0
6.0
dyne/cm²
Hat
41002
P (mb)
1100
1050
1000
950
Hat
41002
T (°C)
30
20
10
0
Hat AIR
41002 AIR
41002 SEA
July
1979
August
Date/Time


1979
August
1 5 10 15 20 25 30 1
Stress
2.0 0 6.0
dyne/cm²
Hat
4 2 0 −2
Stress
2.0 0 6.0
dyne/cm²
41002
4 2 0 −2
P (mb)
1100 1050 1000 950
Hat
41002
T (°C)
30 20 10 0
Hat AIR
41002 AIR
41002 SEA
1 5 10 15 20 25 30 1
August
1979
September
Date/Time


1979
September
October
1
5
10
15
20
25
1
Stress
2.0
0
6.0
dyne/cm²
Hat
41002
4
2
0
−2
P (mb)
1100
1050
1000
950
Hat
41002
T (°C)
30
20
10
0
41002SEA
September
1979
October
Date/Time


1979
October
November
1 5 10 15 20 25 30 1
Stress
2.0 0 6.0
dyne/cm²
Hat
41002
4 2 0 −2
P (mb)
1100 1050 1000 950
Hat
41002
T (°C)
30 20 10 0
Hat_AIR
41002_AIR
41002_SEA
October
1979
November
Date/Time

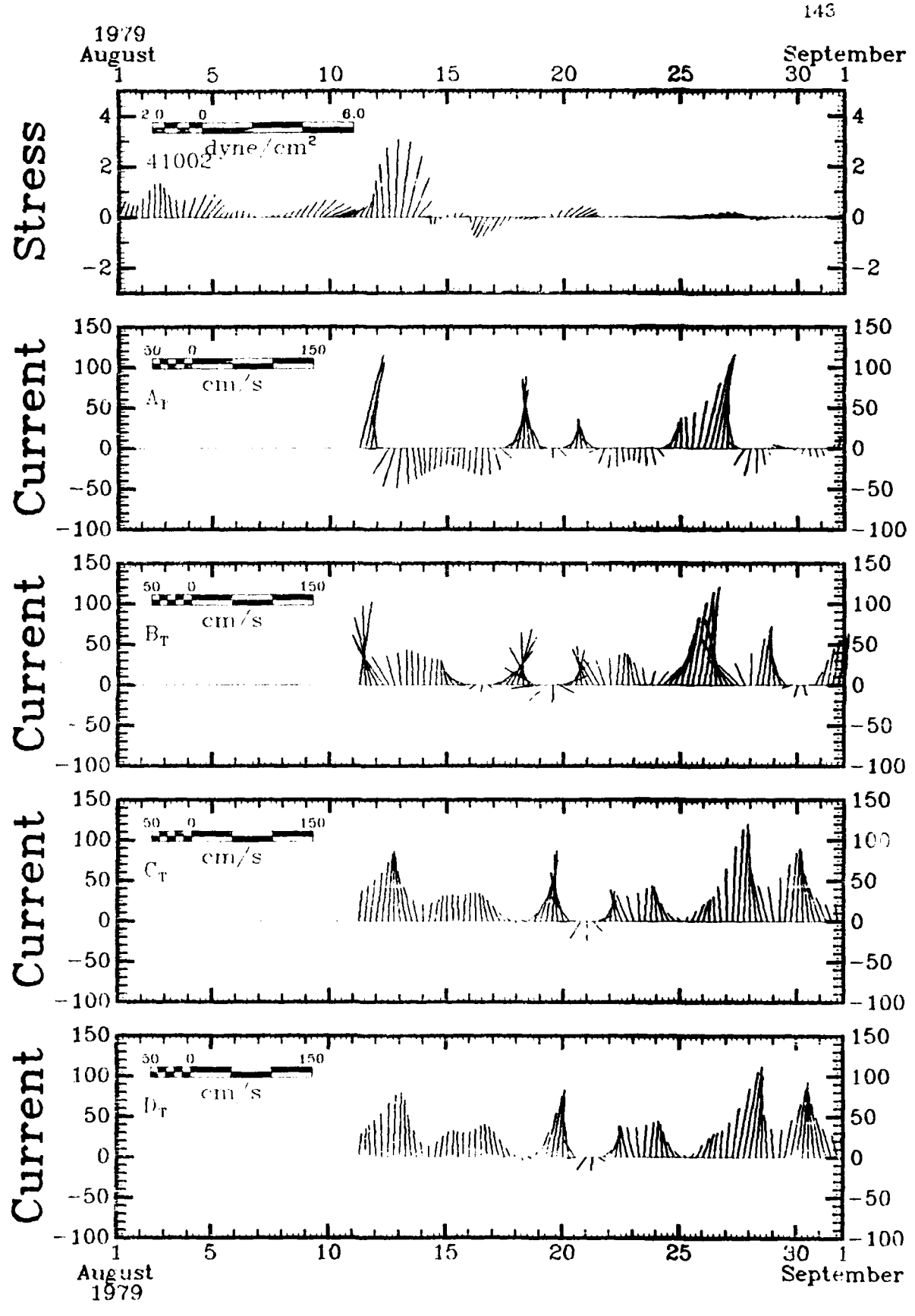

1979
November
December
1
5
10
15
20
25
1
Stress
2.0
0
6.0
dyne/cm²
Hat
41002
P (mb)
1100
1050
1000
950
Hat
41002
T (°C)
30
20
10
0
Hat AIR
41002 AIR
41002 SEA
Date/Time

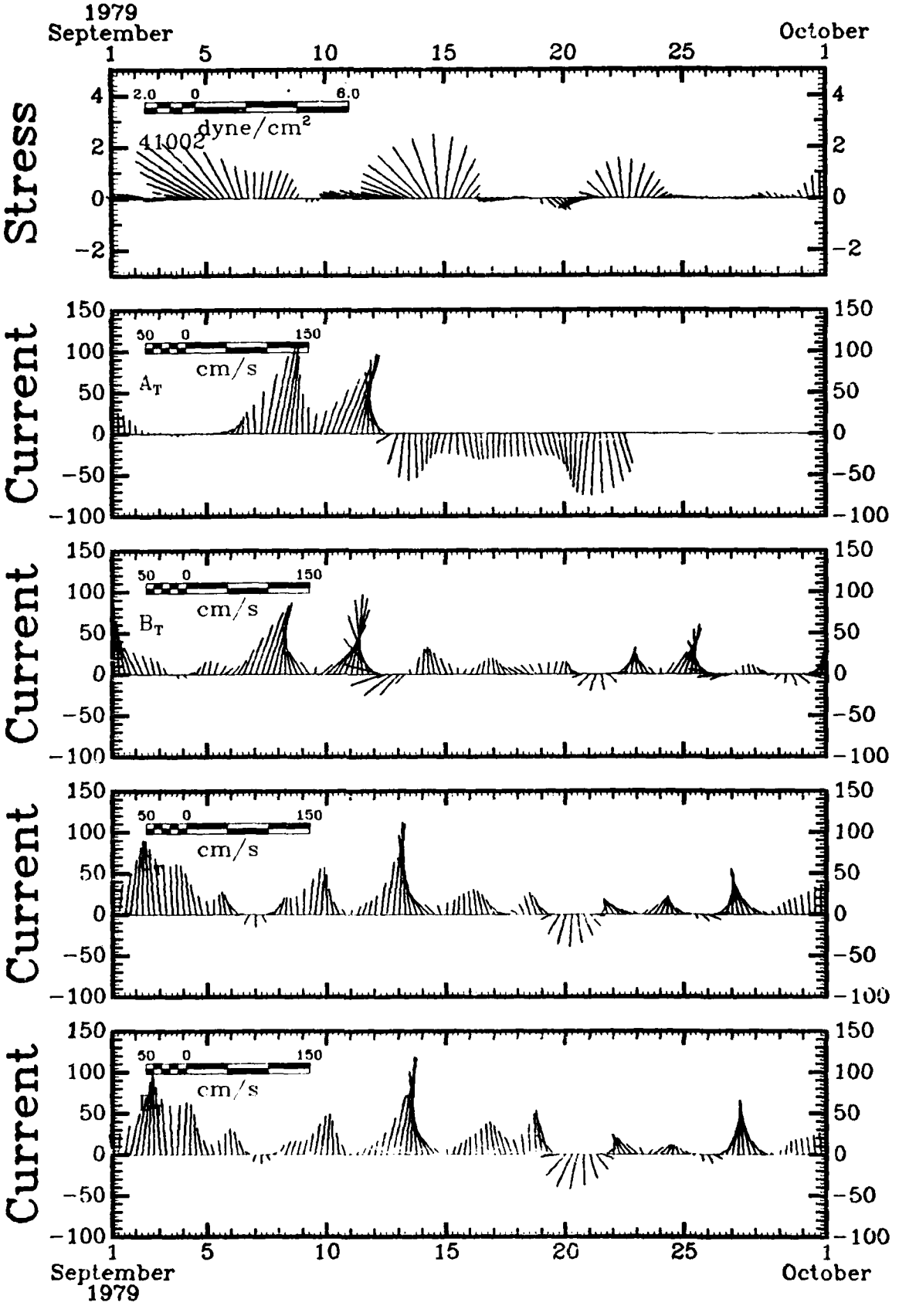

1979
December
1980
January
1 5 10 15 20 25 30 1
2.0 0 6.0
dyne/cm²
Hat
Stress
4 2 0 −2
2.0 0 6.0
dyne/cm²
41002
Stress
4 2 0 −2
1100 1050 1000 950
Hat
41002
P (mb)
30 20 10 0
Hat AIR
41002 AIR
41002 SEA
T (°C)
1 5 10 15 20 25 30 1
December
1979
January
1980
Date/Time

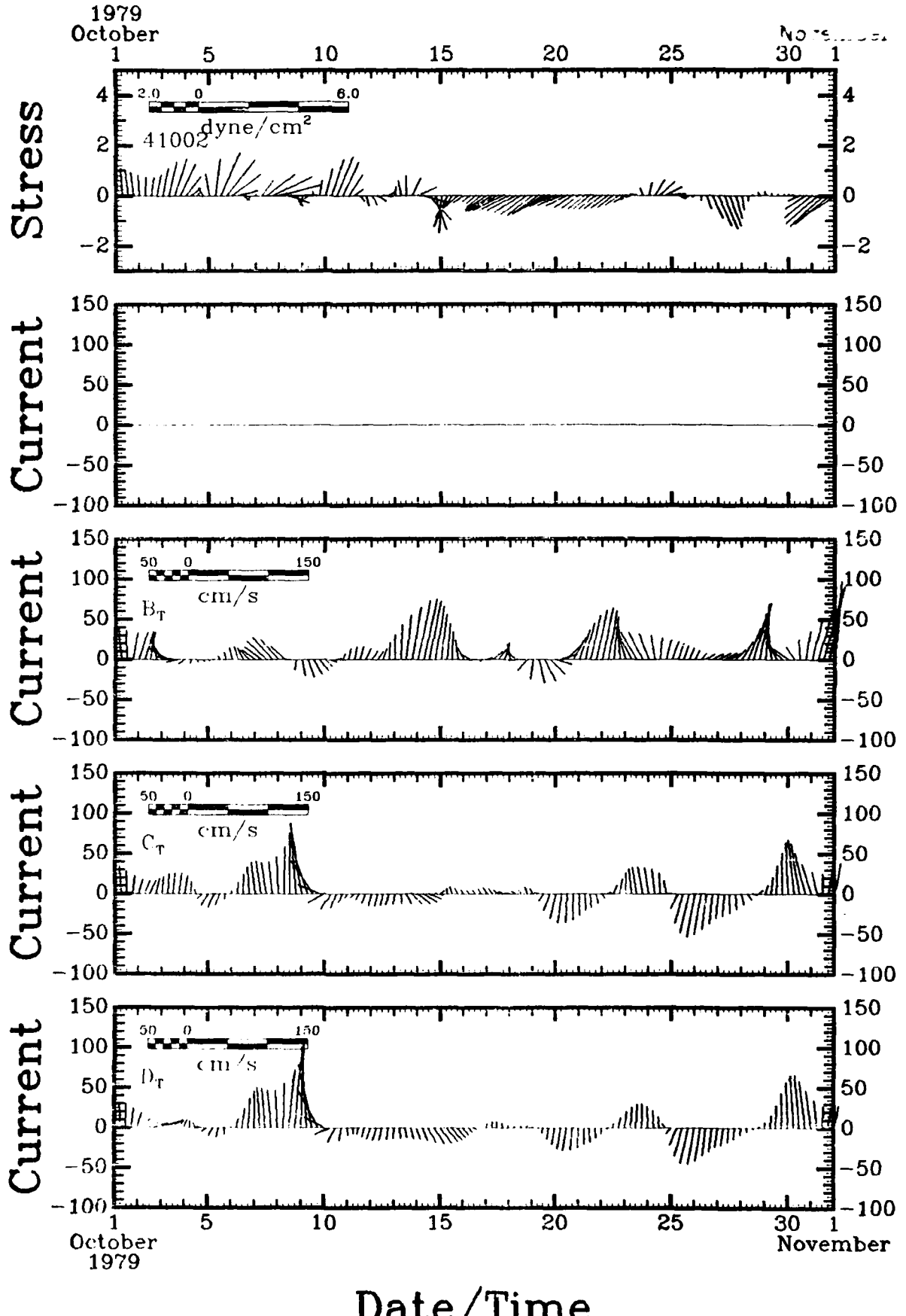
SECTION 8

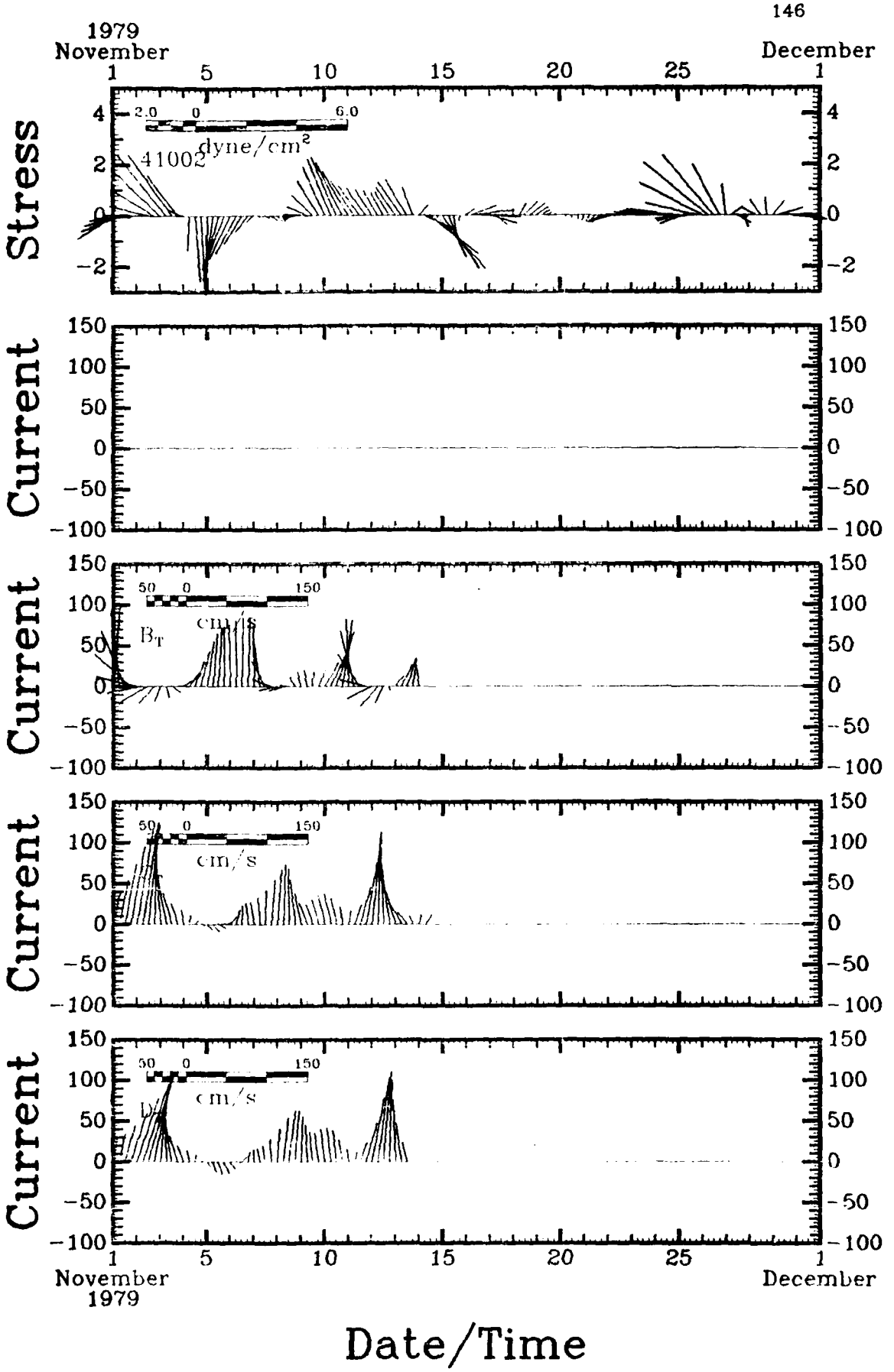
Comparison of 40 HRLP Wind Stress and Current Vector "Sticks"

Figure 40 shows by month the 40 HRLP NDBO-2 wind stress vector "sticks" and the 40 HRLP current vector "sticks" for the topmost instrument on each mooring. Vectors pointing toward the top of the page correspond to flow in the downstream (34°T) direction. Common scaling is used in this section. Very little correlation is evident between the wind stress and currents.


1979
August
September
1
5
10
15
20
25
30
1
Stress
41002
dyne/cm²
Current
A_T
B_T
C_T
D_T
cm/s
August
1979
September
Date/Time


1979
September
October
1
5
10
15
20
25
1
Stress
2.0
0
6.0
dyne/cm²
41002
4
2
0
−2
Current
50
0
150
cm/s
A_T
B_T
150
100
50
0
−50
−100
September
1979
Date/Time

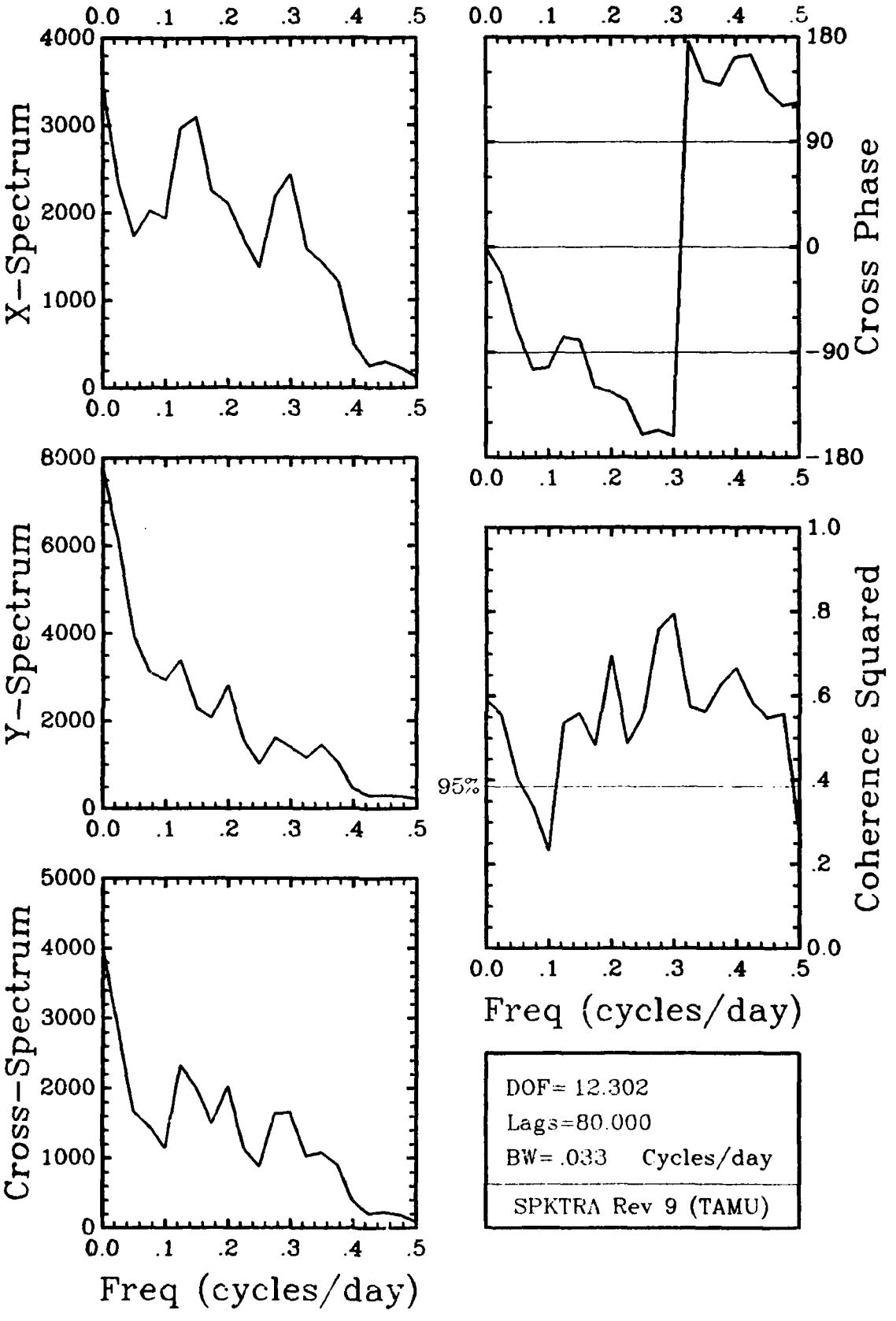

1979
October
1 5 10 15 20 25 30 1
Stress
2.0 0 6.0
dyne/cm²
41002
Current
Current
50 0 150
cm/s
B_T
Current
50 0 150
cm/s
C_T
Current
50 0 150
cm/s
D_T
1 5 10 15 20 25 30 1
October
1979
November
Date/Time


1979
November
December
1 5 10 15 20 25 1
Stress
2.0 0 6.0
dyne/cm²
41002
Current
Current
50 0 150
cm/s
B_T
Current
50 0 150
cm/s
Current
50 0 150
cm/s
150 100 50 0 −50 −100
1 5 10 15 20 25 1
November
1979
December
Date/Time

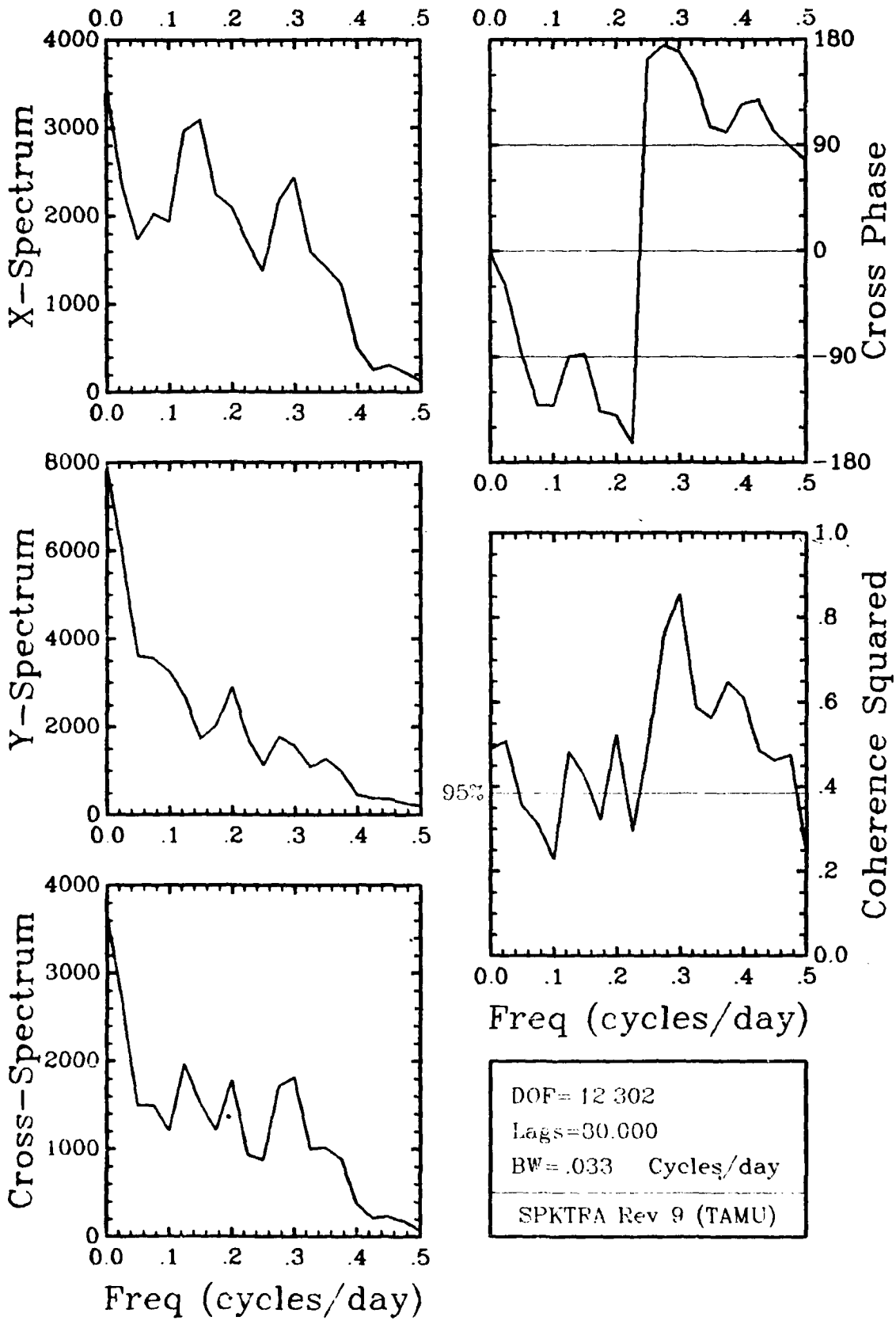
SECTION 9

Spectrum Calculations for Various Combinations of 40 HRLP Data Sets

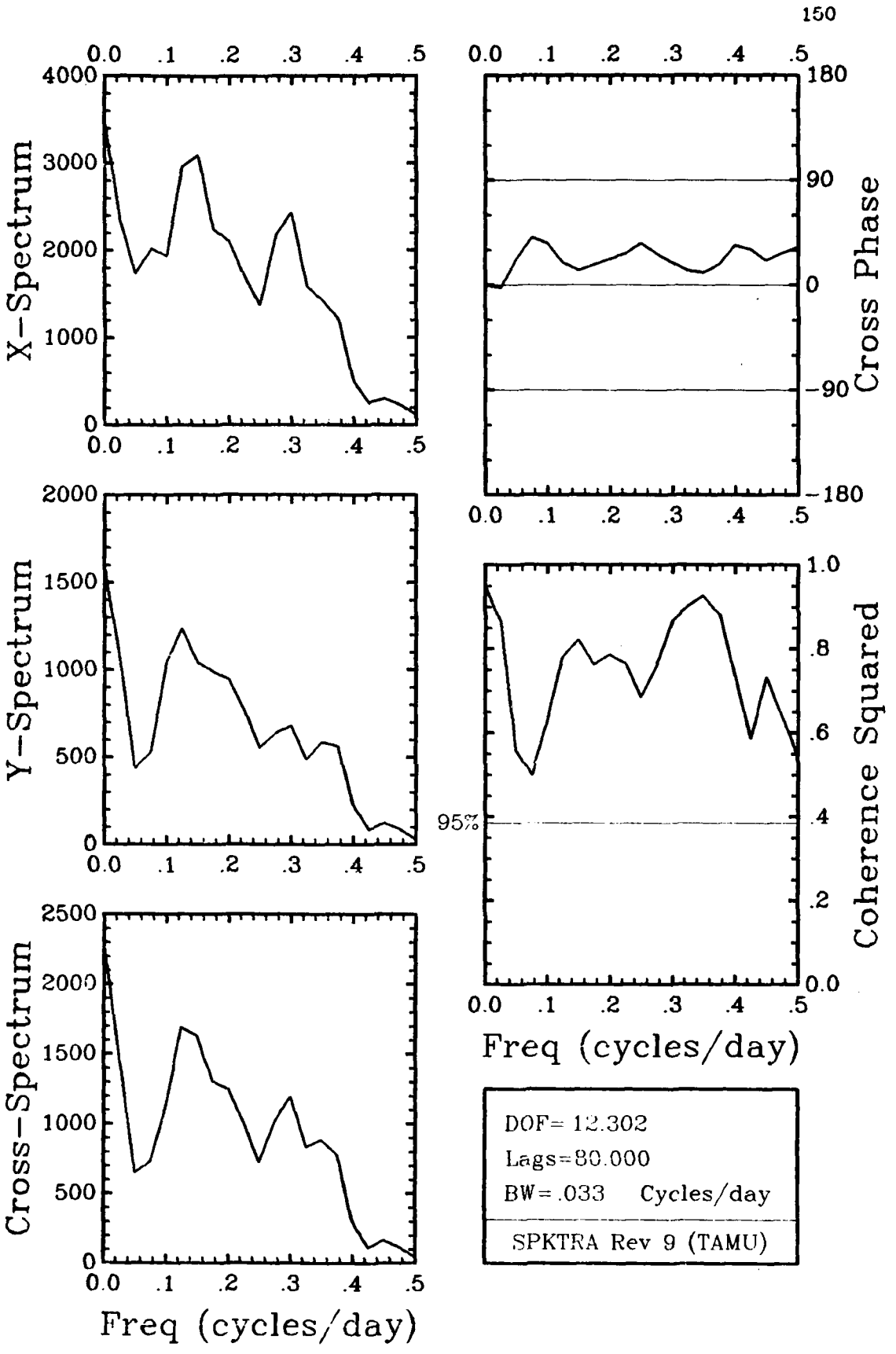
Figures 41 through 73 show spectrum, cross-spectrum, phase, and coherence squared calculations for selected combinations of 40 HRLP current components, Hatteras and NDBO wind stress components. The naming convention gives the "X" time series first and the "Y" time series second. Currents are identified by mooring letter, and instrument position on the mooring is given by subscript letter. The phase convention is such that negative phase values mean the "Y" series lags the "X" series. The spectrum ordinate units in all cases are variance units per cycle per day (CPD), where the variance units are those appropriate for the time series in question. Root-mean-square estimates of a variable in a particular frequency band can be obtained by multiplying the spectrum estimate in that band by the effective bandwidth (0.033 CPD in all cases) and taking the square root of the product. The 95% significance level for coherence squared, the level below which would fall 95% of the coherence estimates between truly uncorrelated variates, is shown by a horizontal line on the coherence graphs. Spectrum estimates nominally possess 15 degrees of freedom (DOF), although some variation in this number, accepted in favor of maintaining the bandwidth invariant, results from differing record lengths. For 15 DOF, the 95% confidence interval on the phase estimate in a particular frequency band is approximately ± (27, 18, 12) degrees for a coherence squared value of (0.4, 0.6, 0.8) in that band.



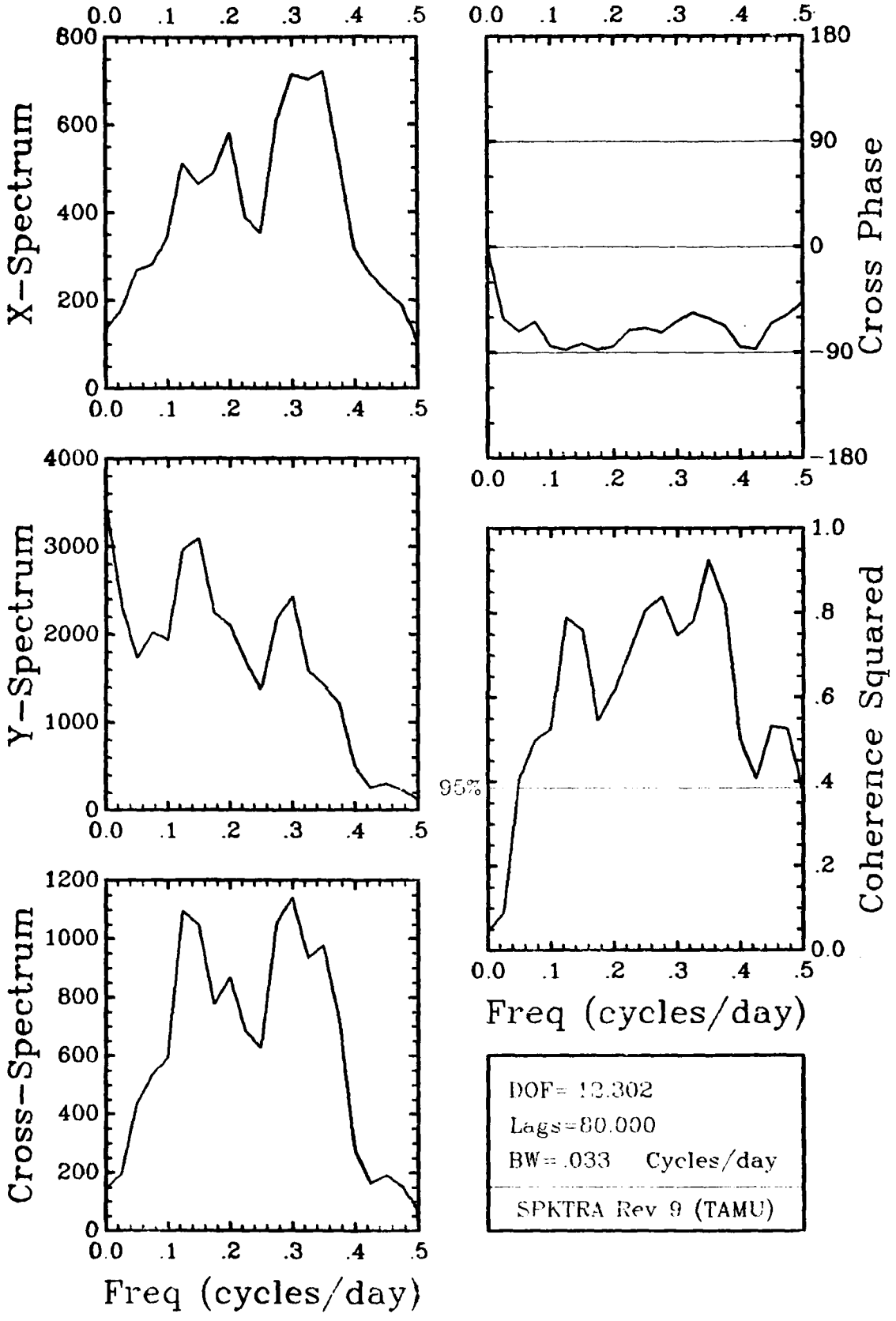
B_T V / C_T V Summer 40 HR LP



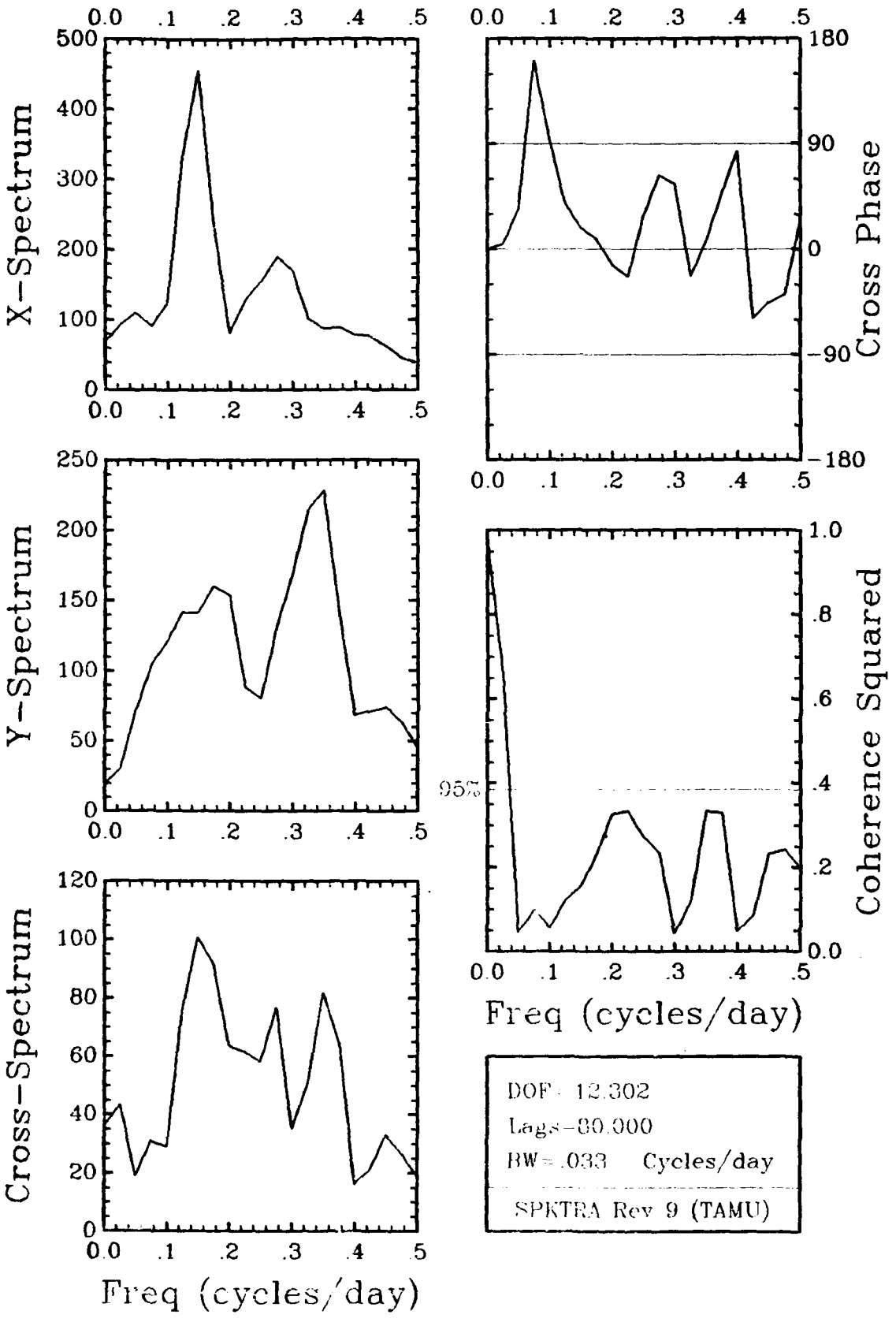
B_T V / D_T V Summer 40 HR LP



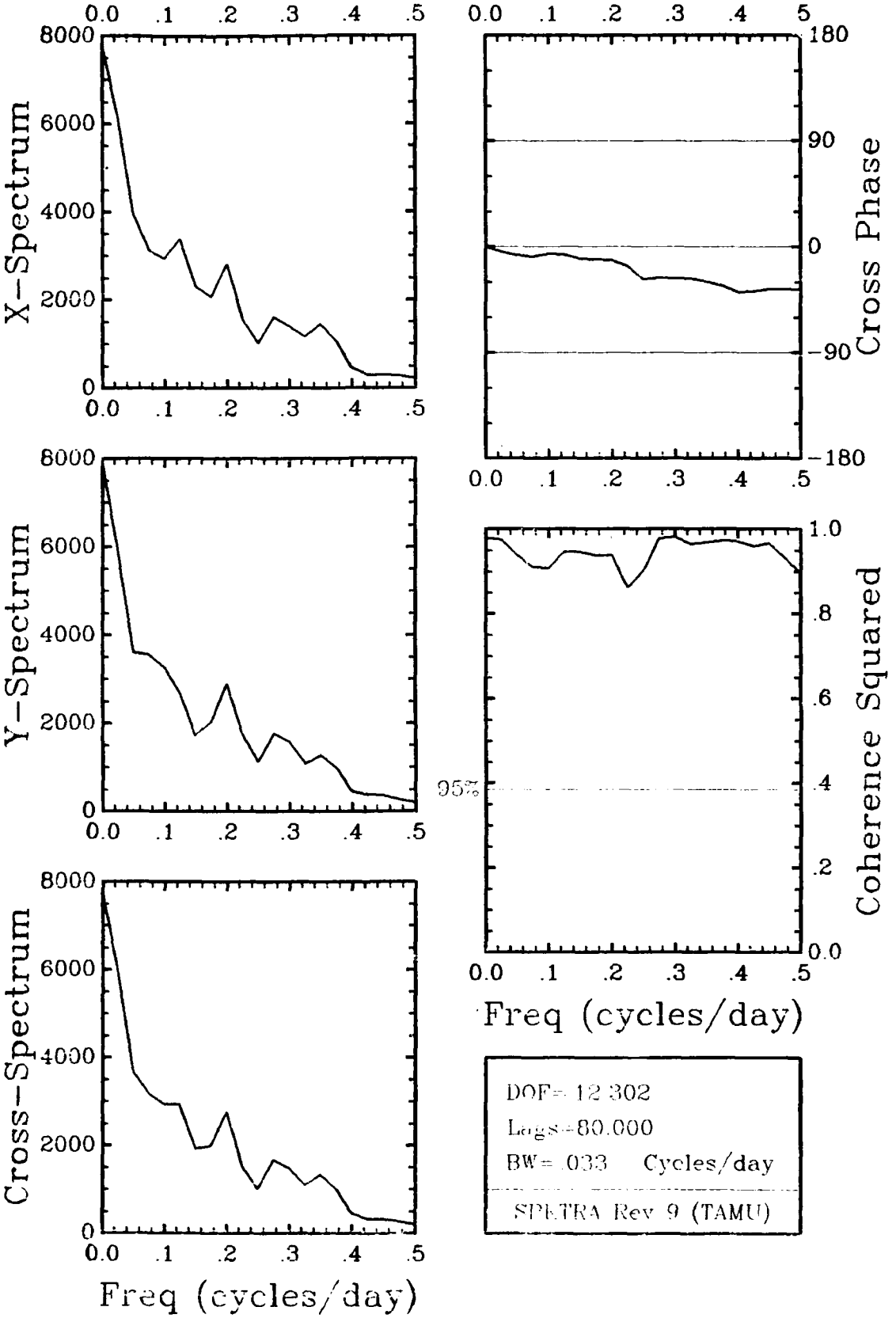
B_T V / B_B V Summer 40 HR LP



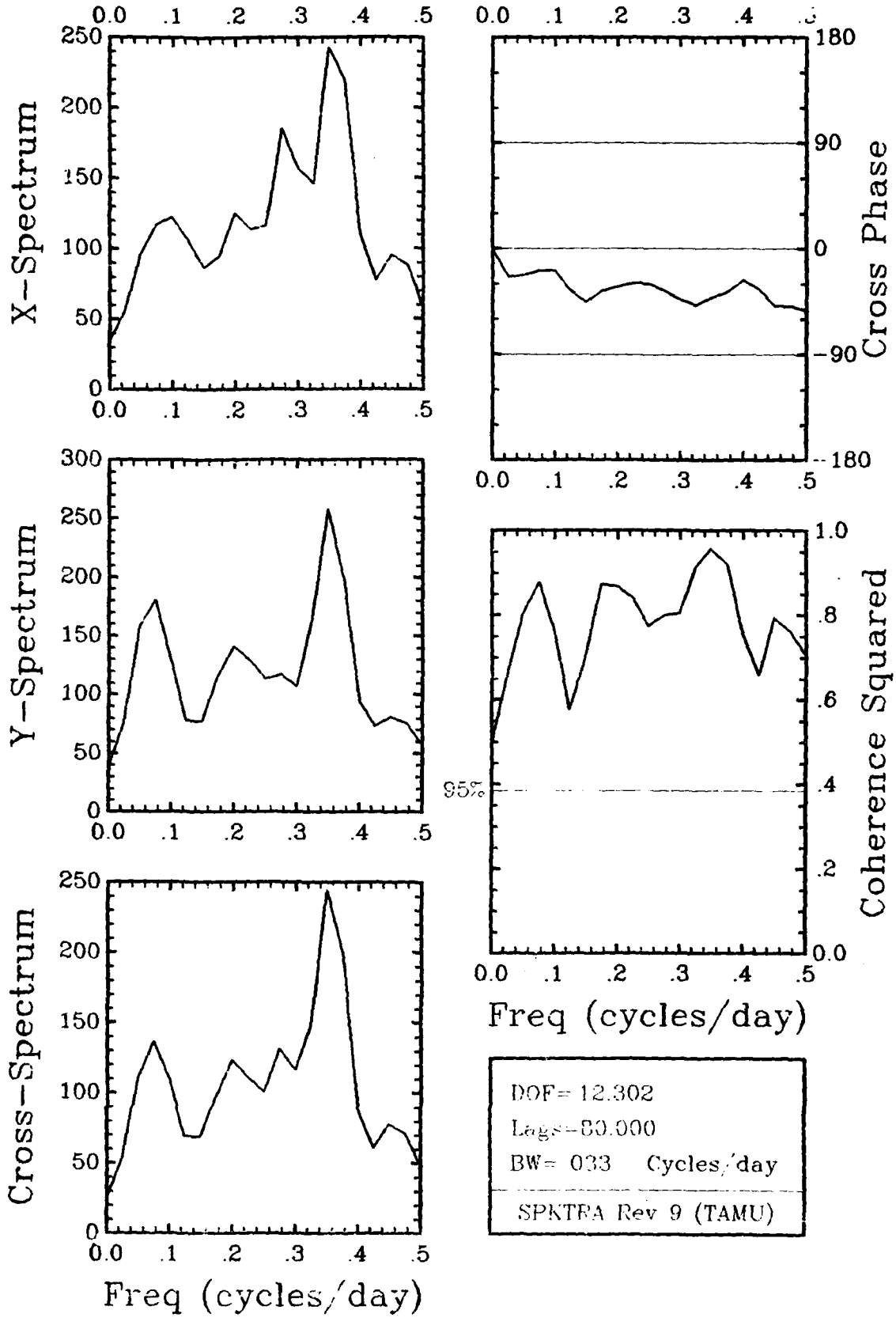
B_T U / B_T V Summer 40 HR LP



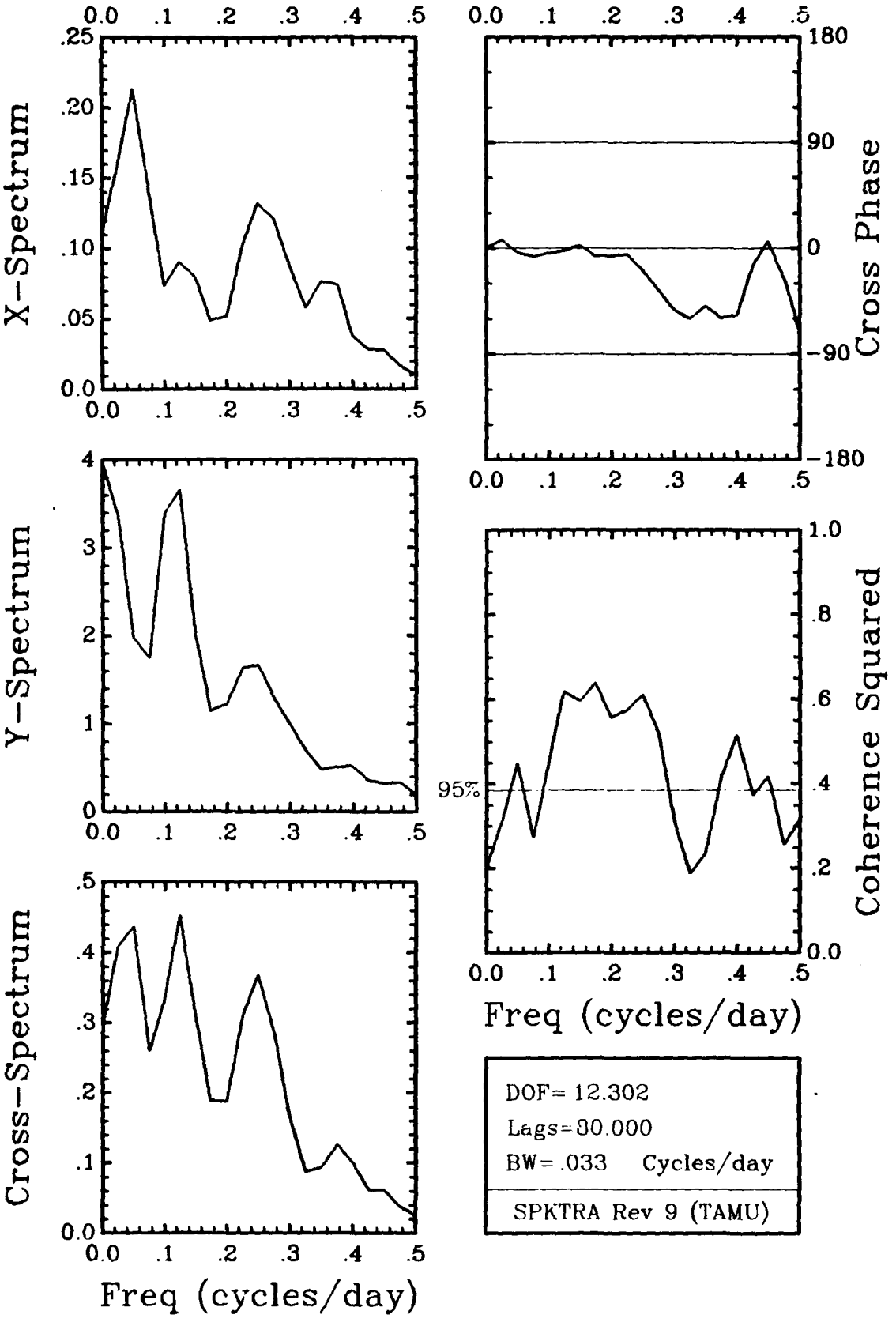
A_B U / B_B U Summer 40 HR LP



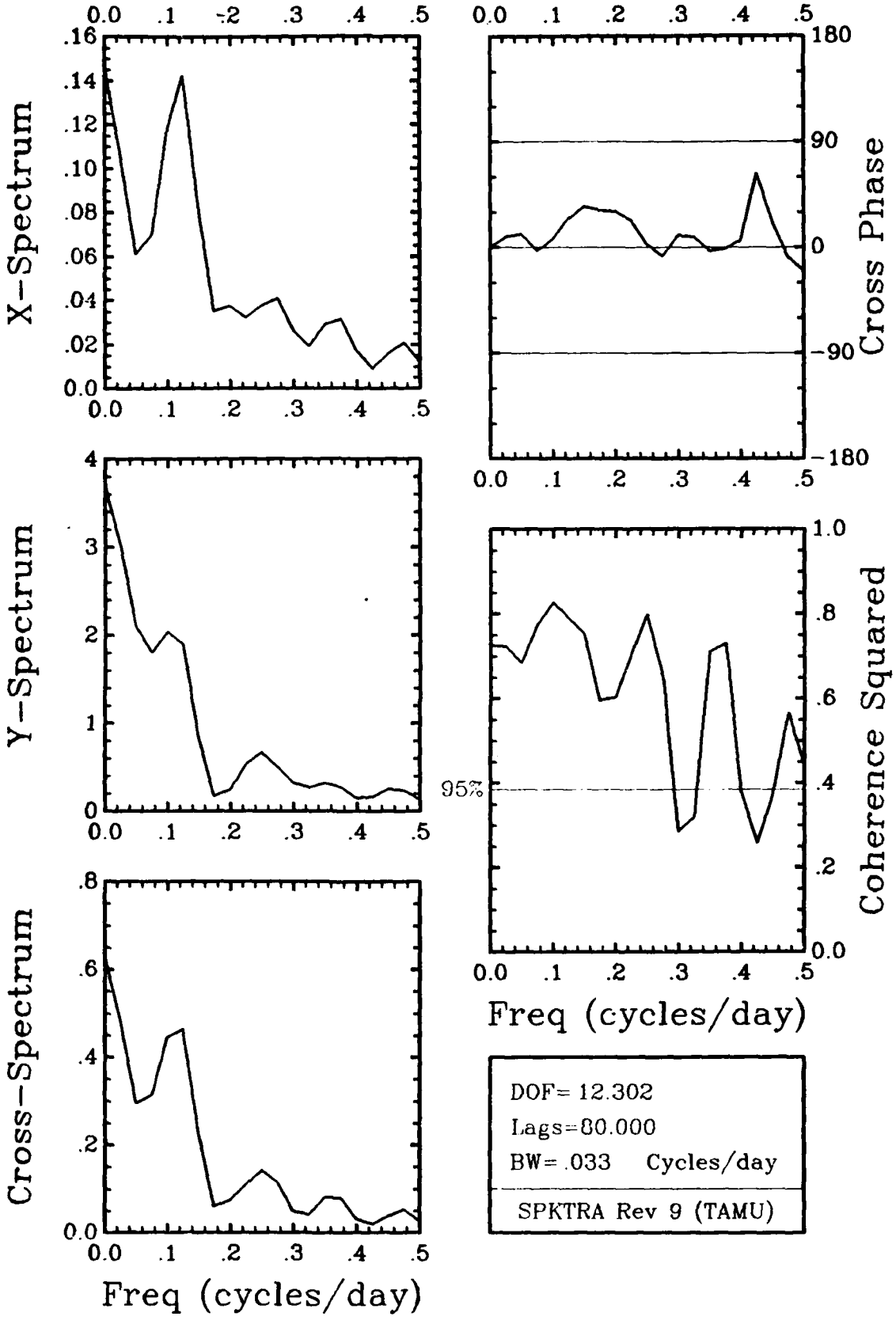
C_T V / D_T V Summer 40 HR LP



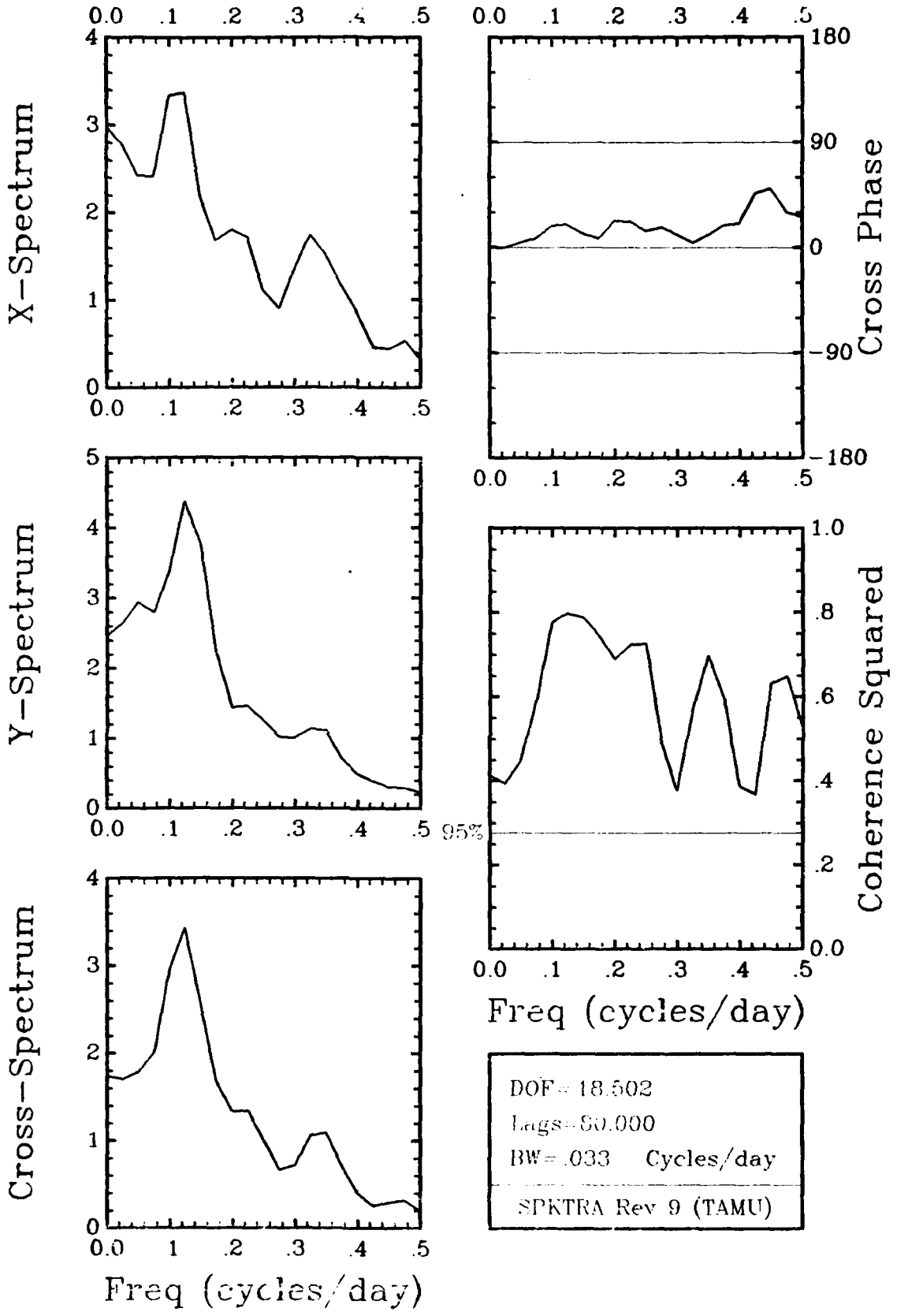
C_T U / D_T U Summer 40 HR LP



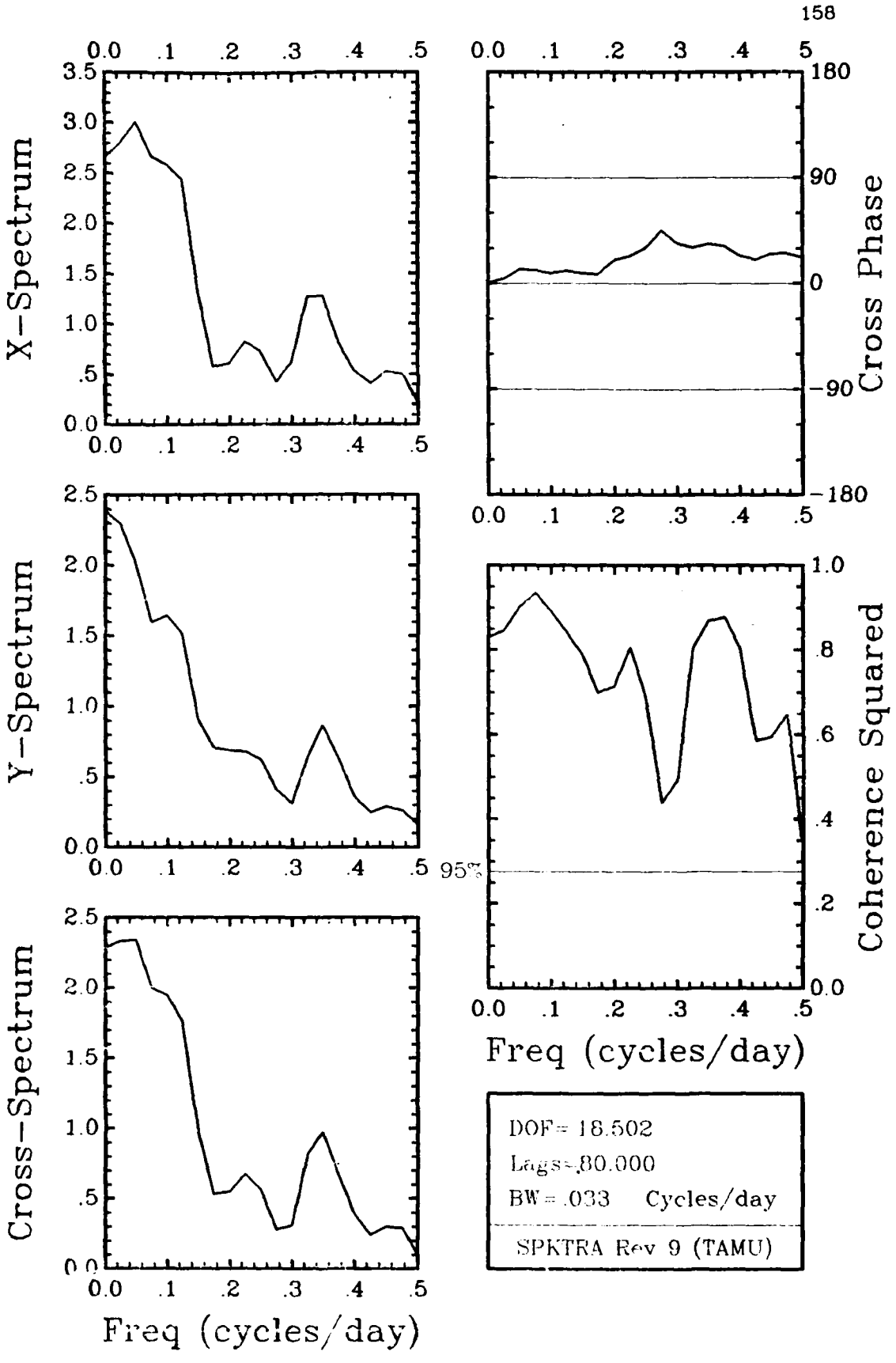
V-Stress$_{HAT}$ / V-Stress$_{41002}$ Summer 40 HR LP



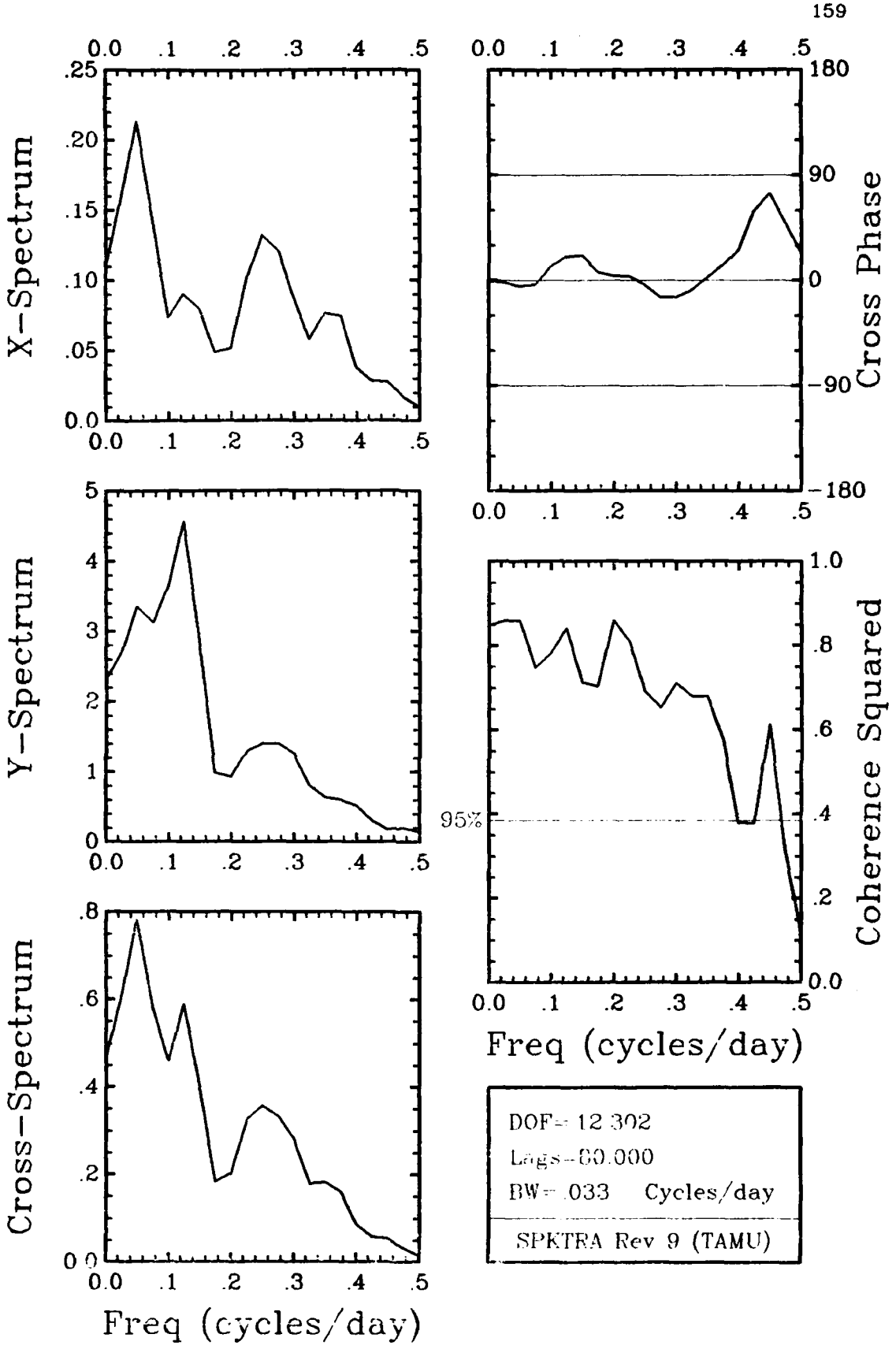
U-Stress$_{HAT}$ / U-Stress$_{41002}$ Summer 40 HR LP



$V\text{-}Stress_{41002}$ / $V\text{-}Stress_{41004}$ Summer 40 HR LP



U-Stress$_{41002}$ / U-Stress$_{41004}$ Summer 40 HR L



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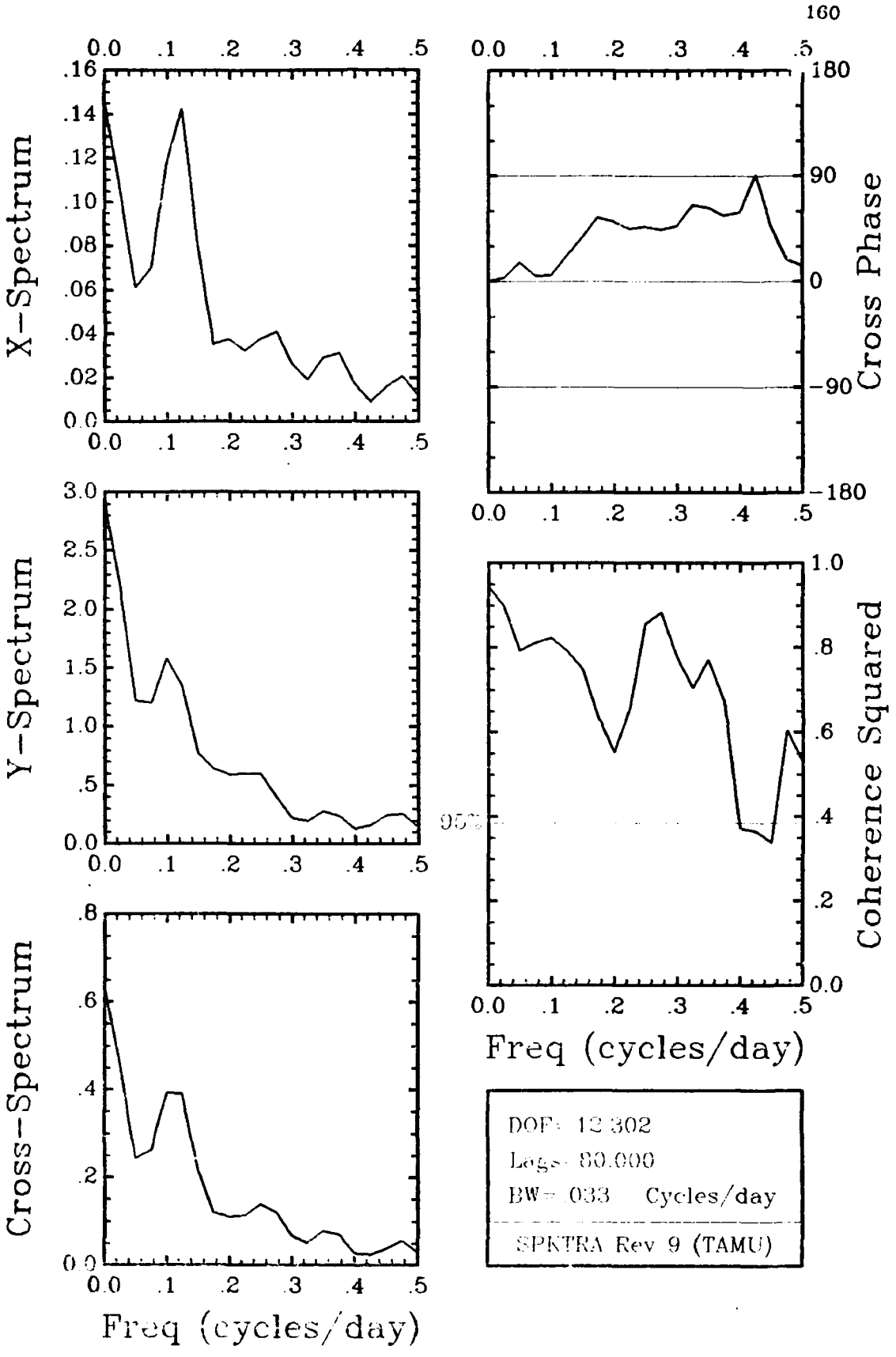
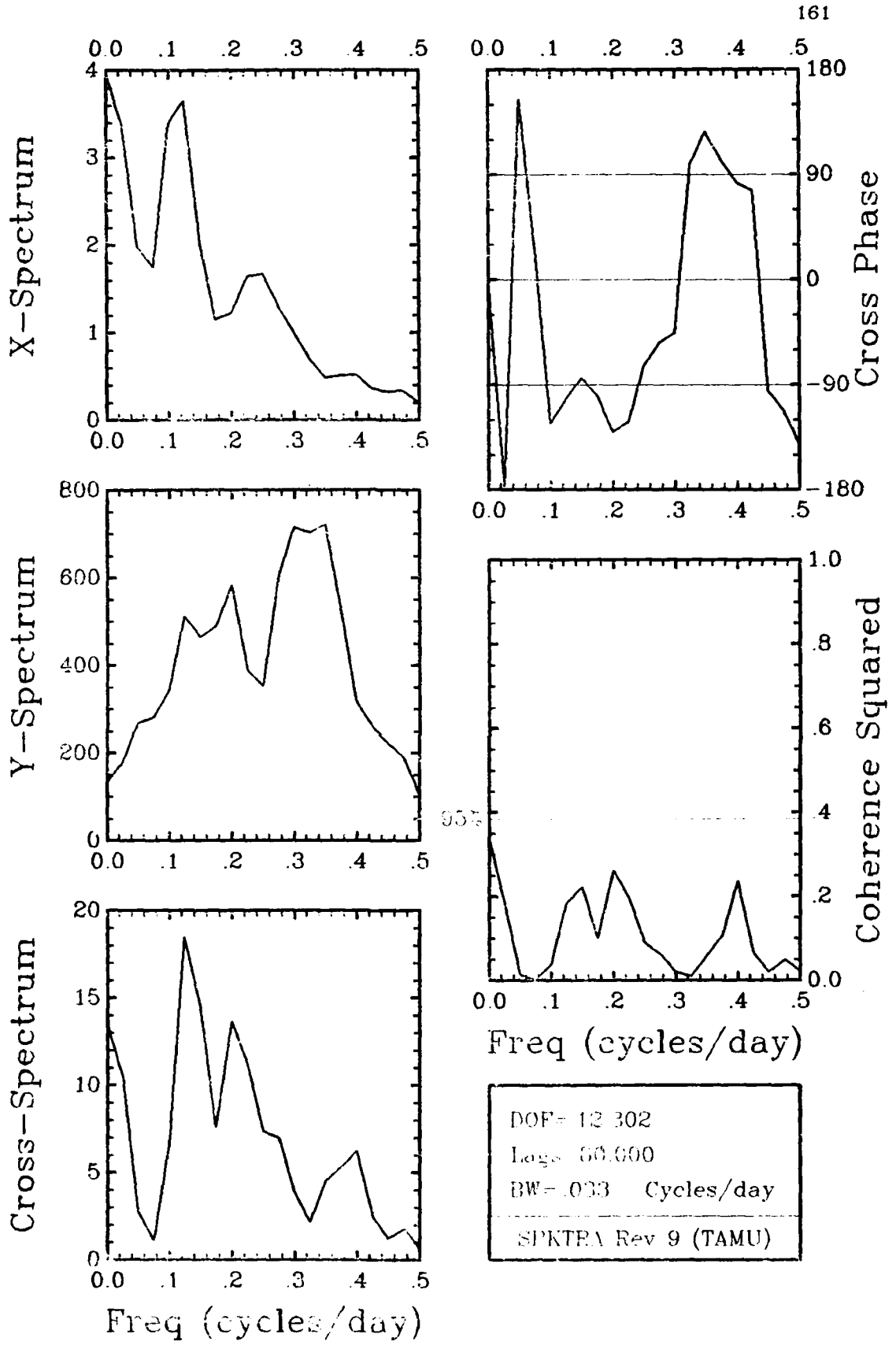
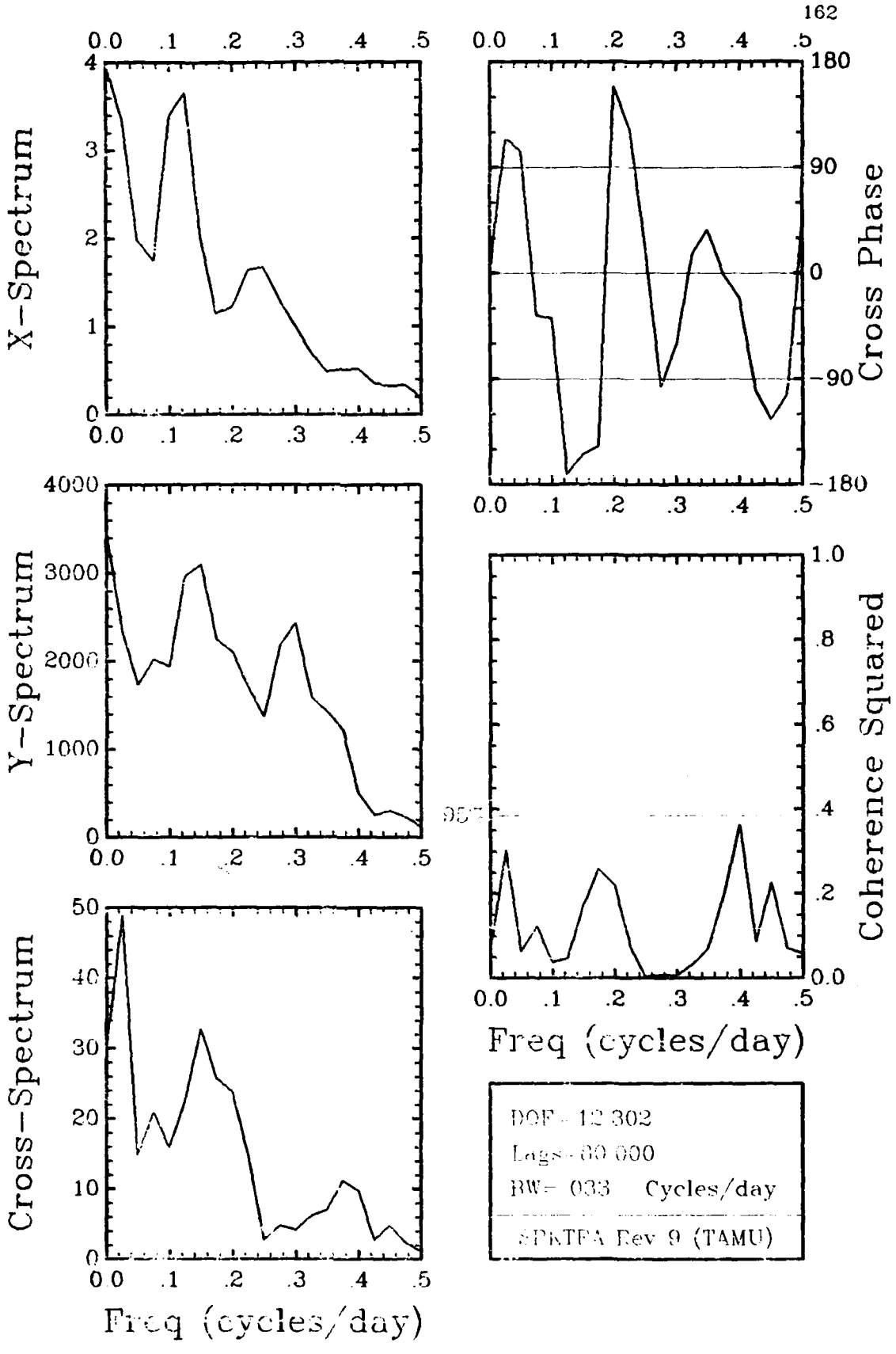


U-Stress$_{HAT}$ / U-Stress$_{41004}$ Summer 40 HR LP



V-Stress$_{41002}$ / B$_T$U Summer 40 HR LP



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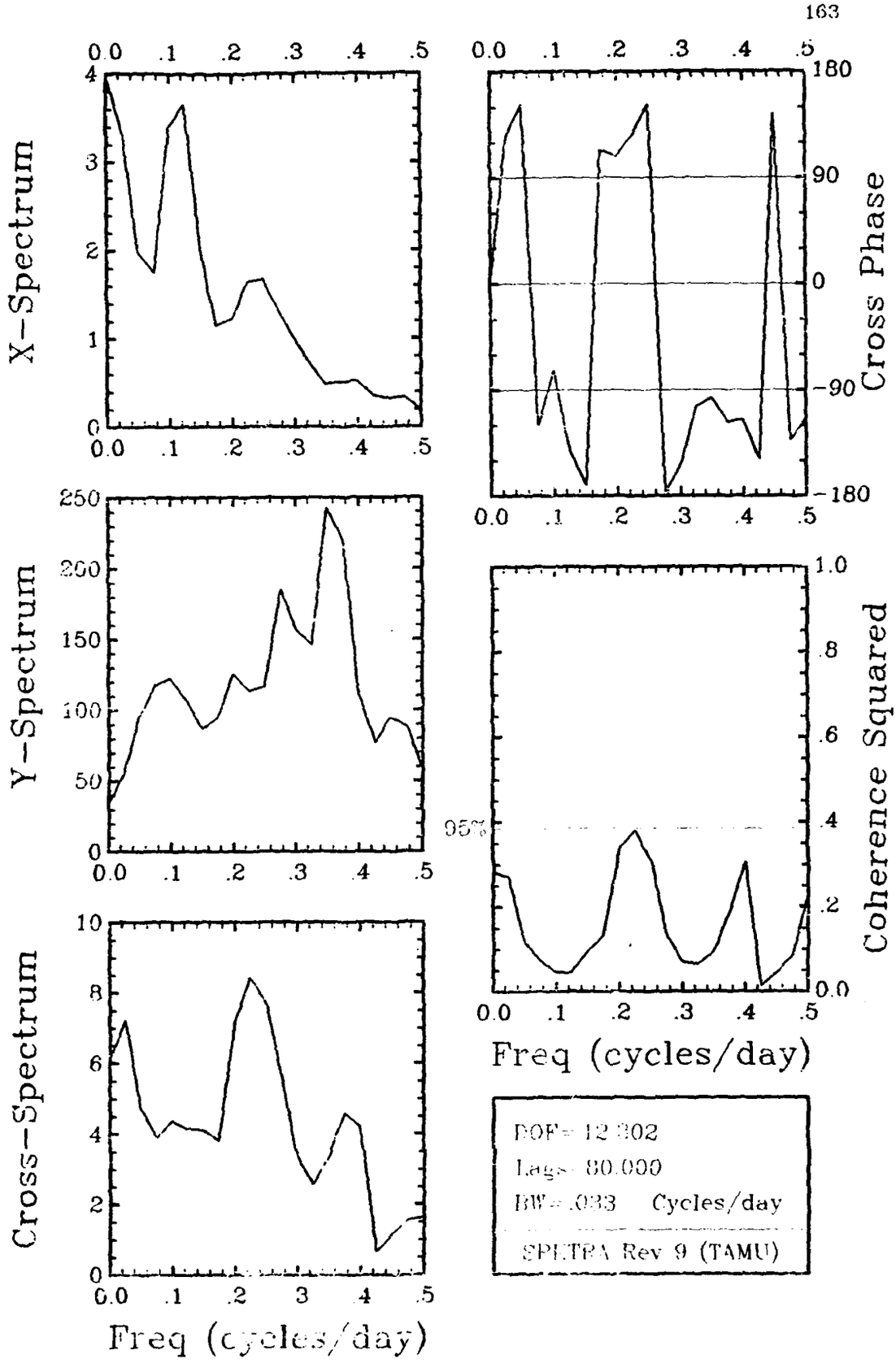
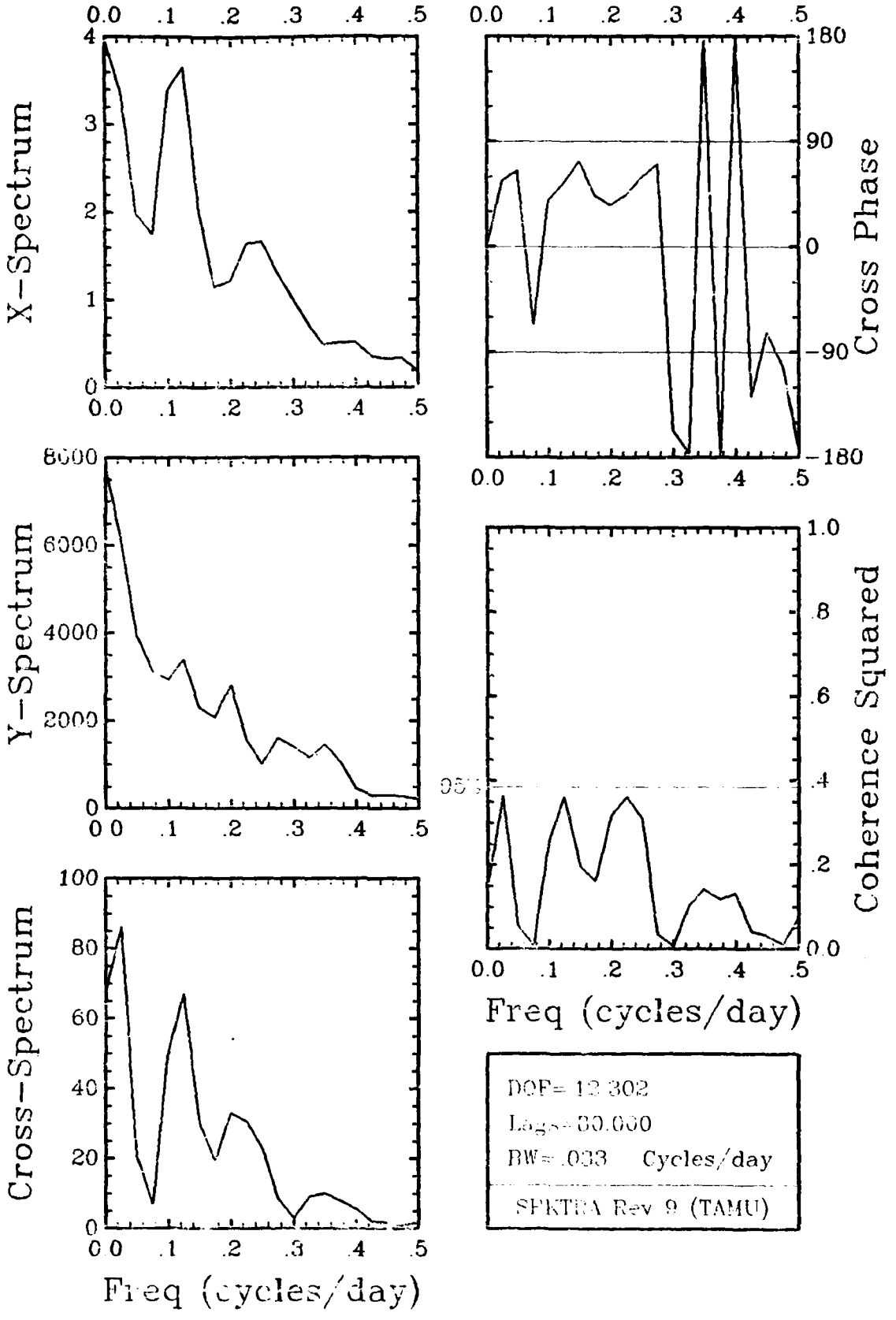
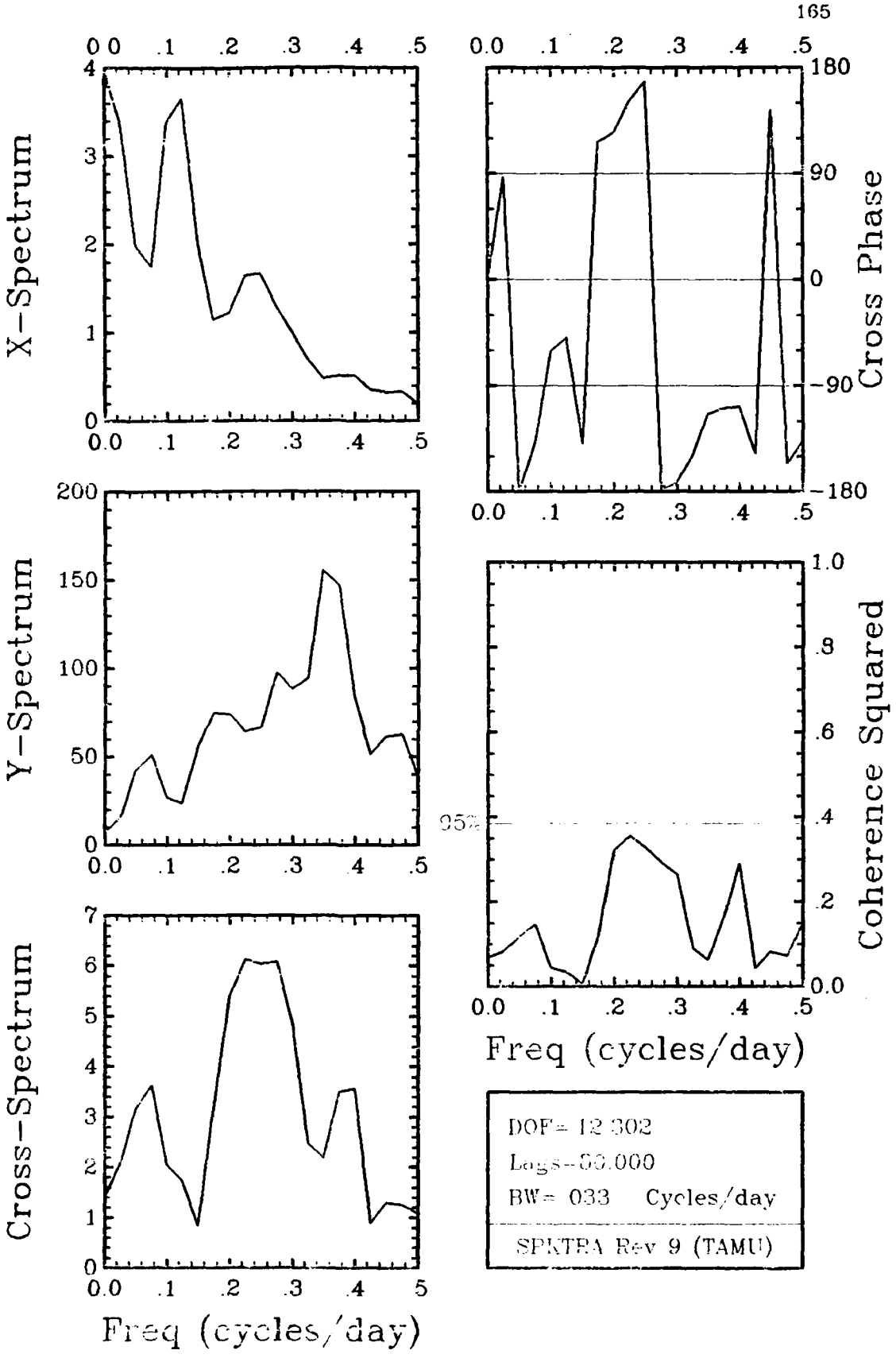


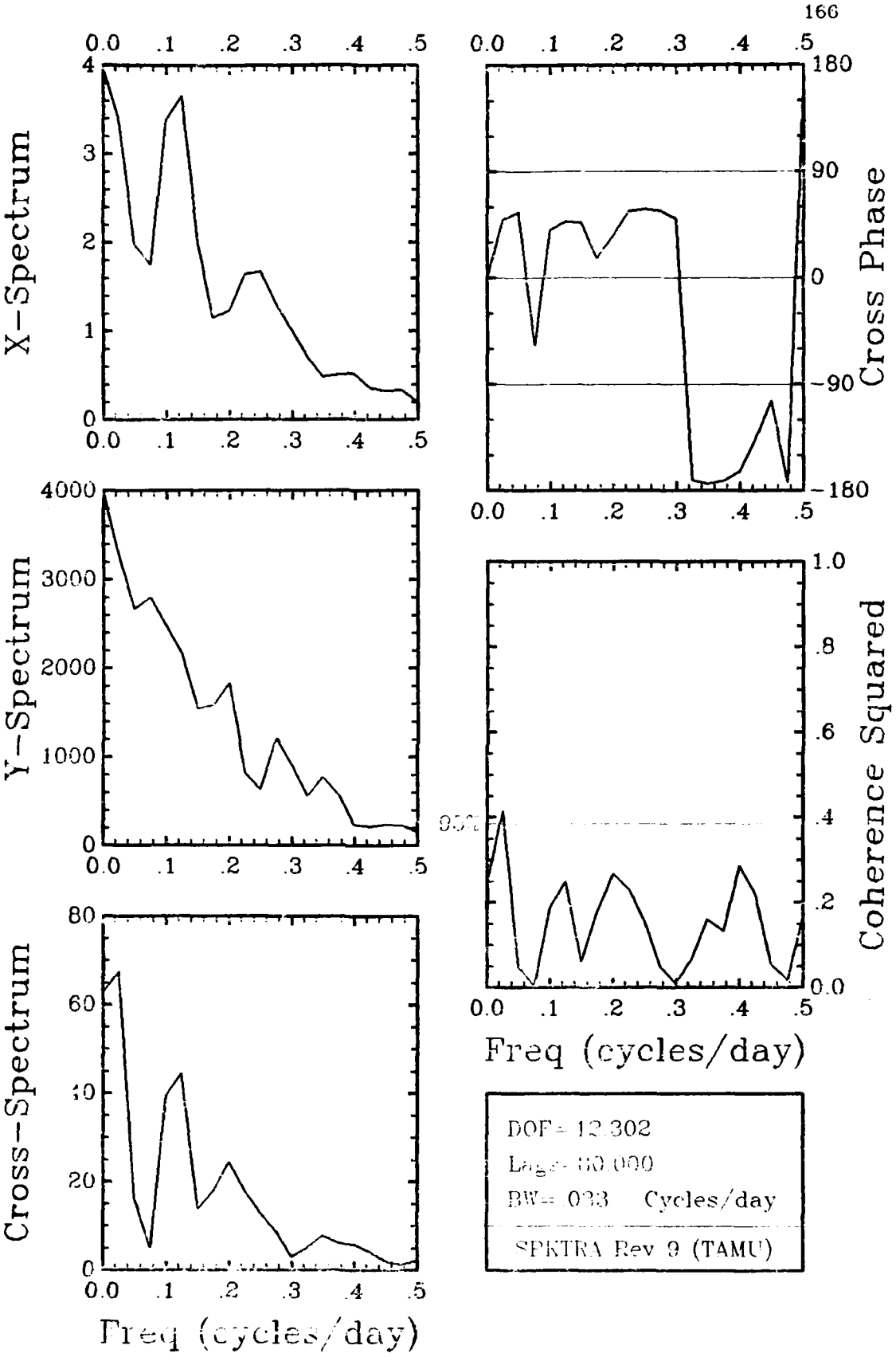
V-Stress$_{41002}$ / C$_T$U Summer 40 HR LP



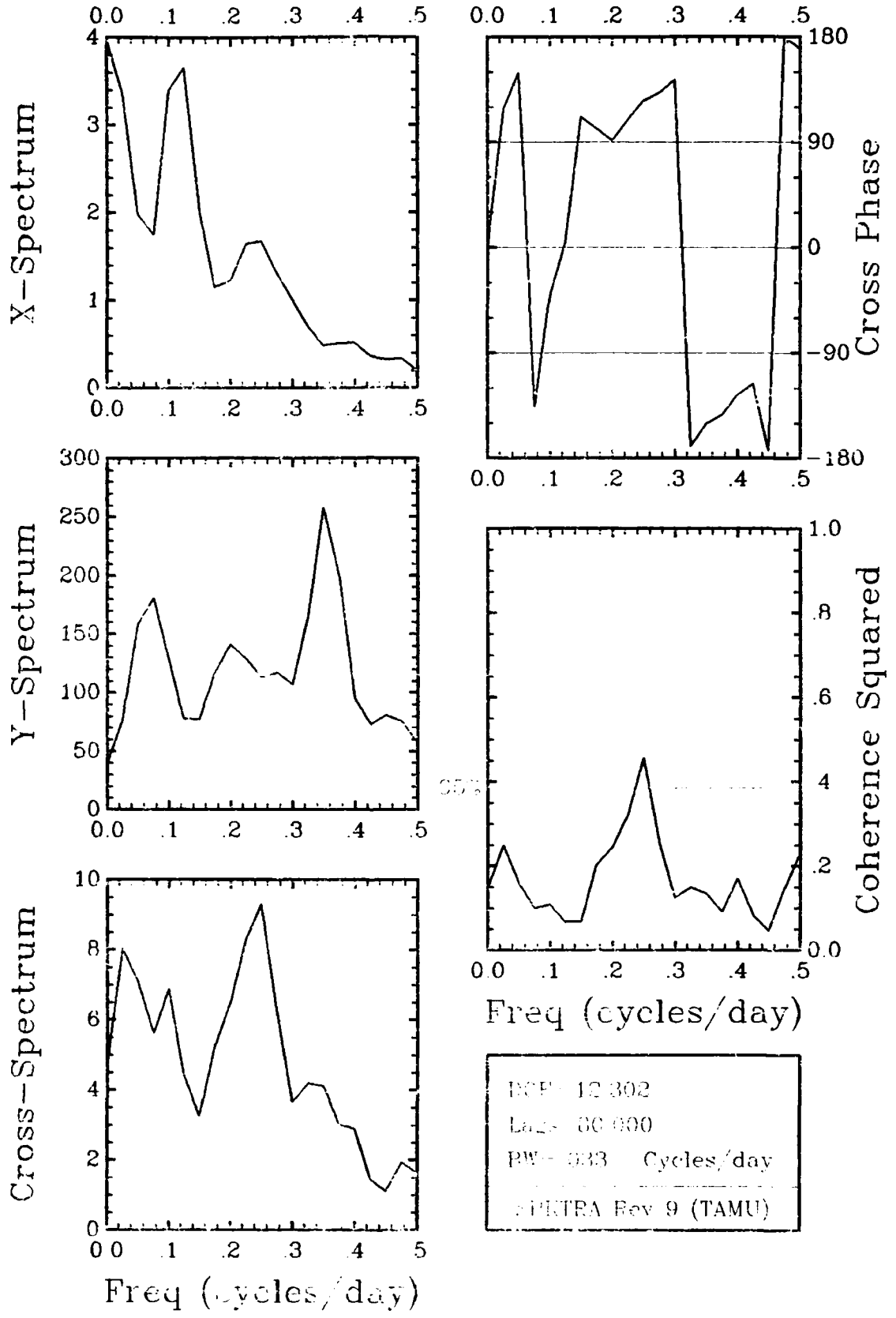
V-Stress$_{41002}$ / C_TV Summer 40 HR LP



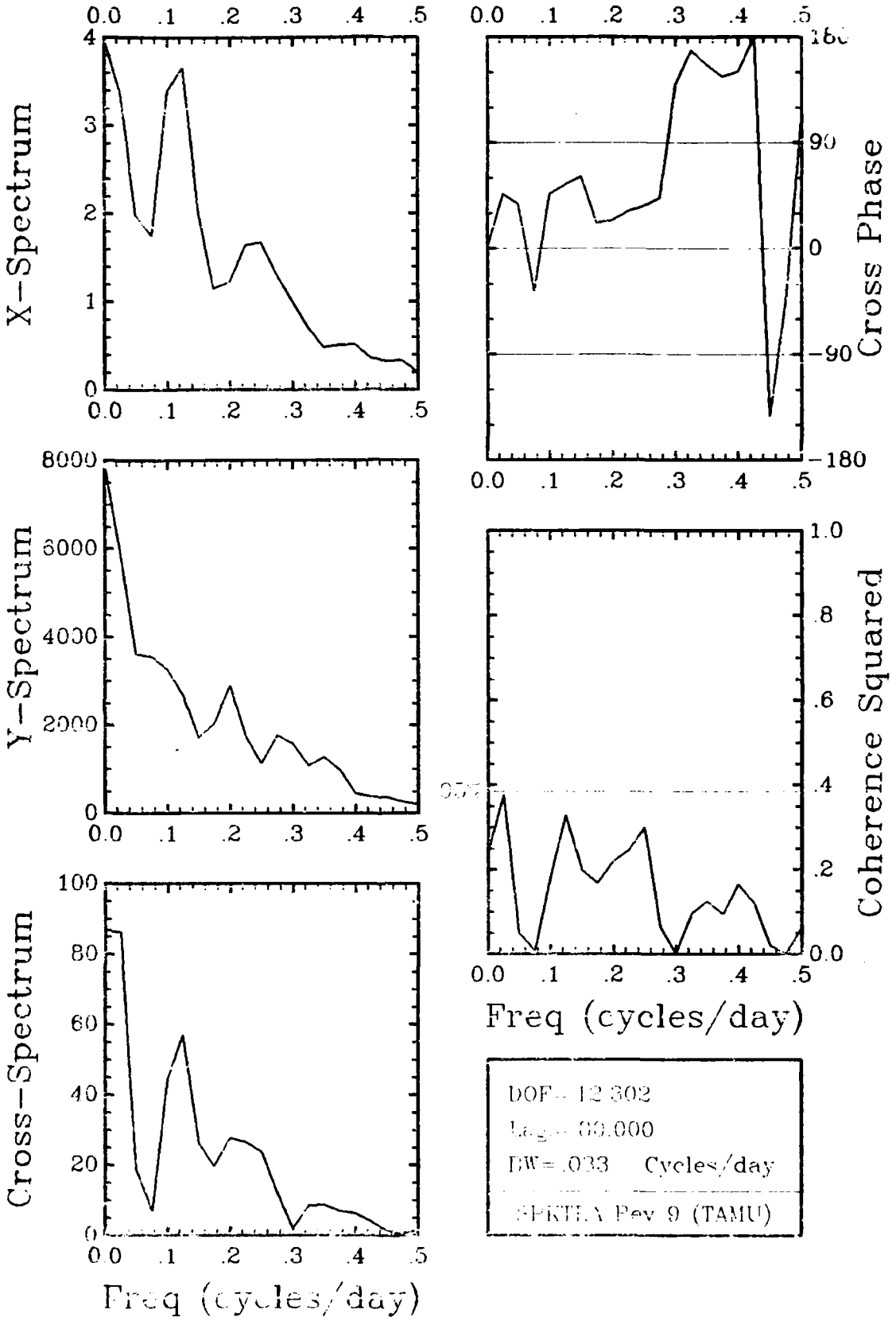
V-Stress$_{41002}$ / C$_M$U Summer 40 HR LP



V-Stress$_{41002}$ / C$_M$V Summer 40 HR LP



V-Stress$_{41002}$ / D_TU Summer 40 HR LP



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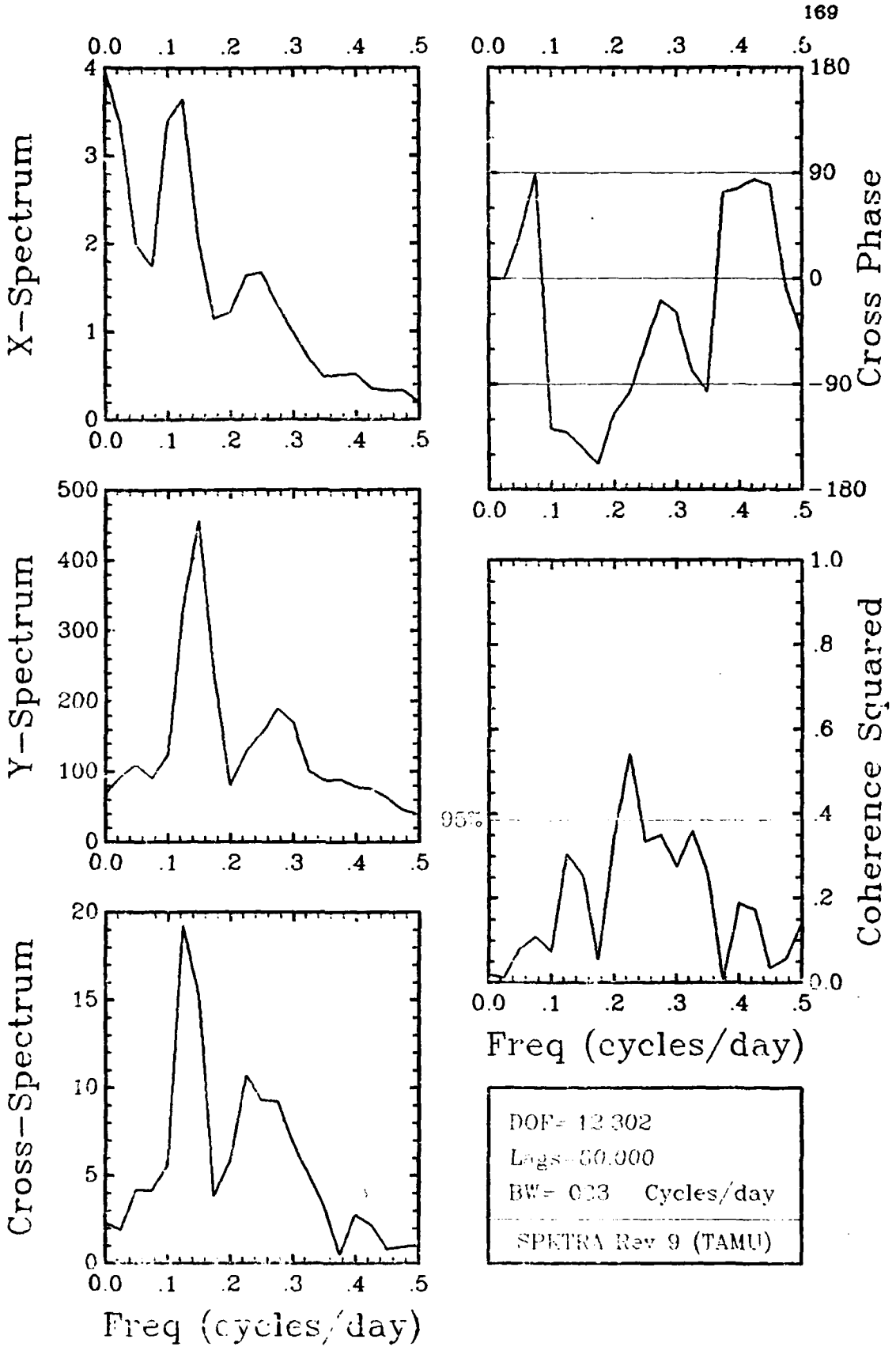
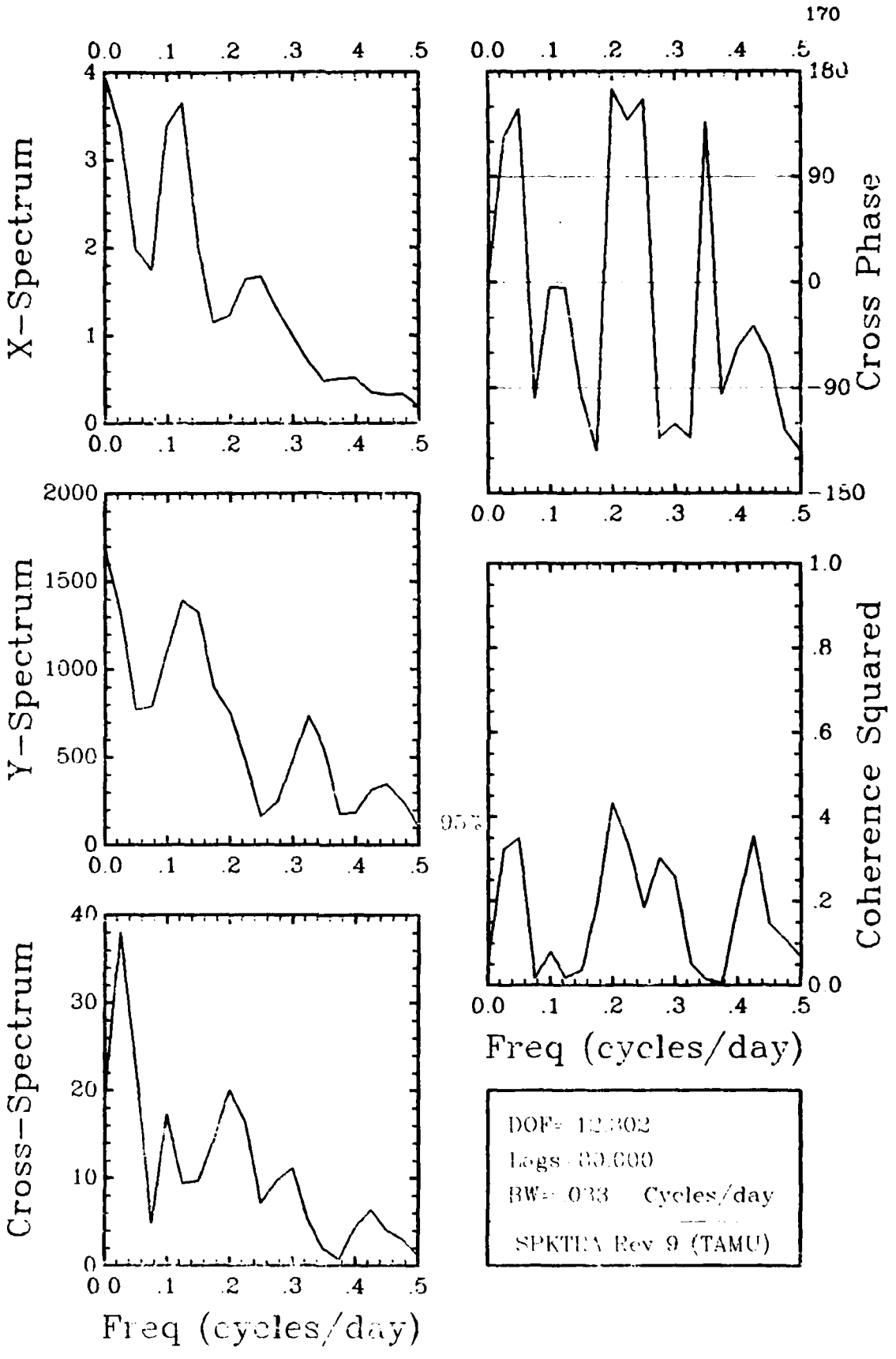


V-Stress$_{41002}$ / A$_B$U Summer 40 HR LP



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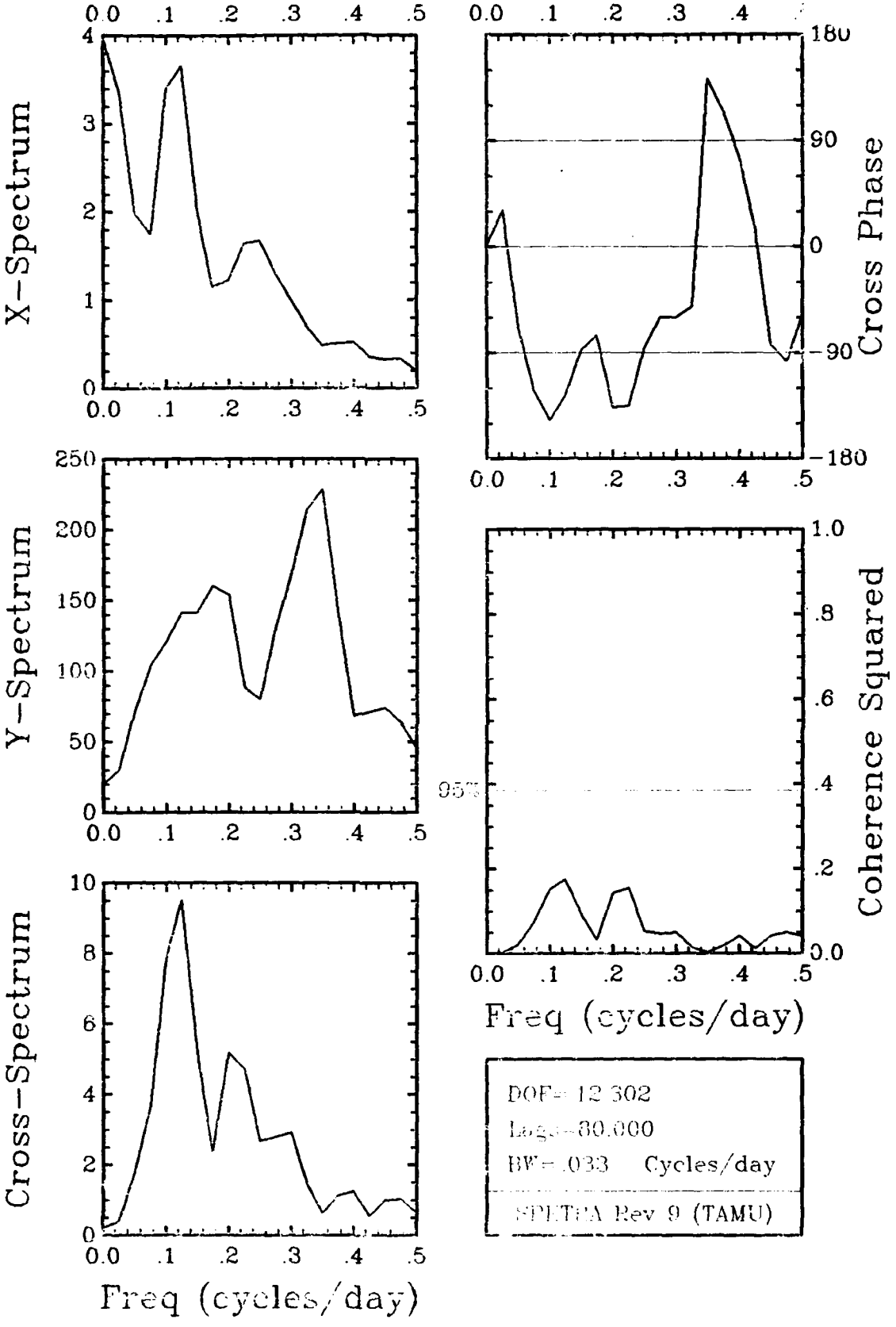
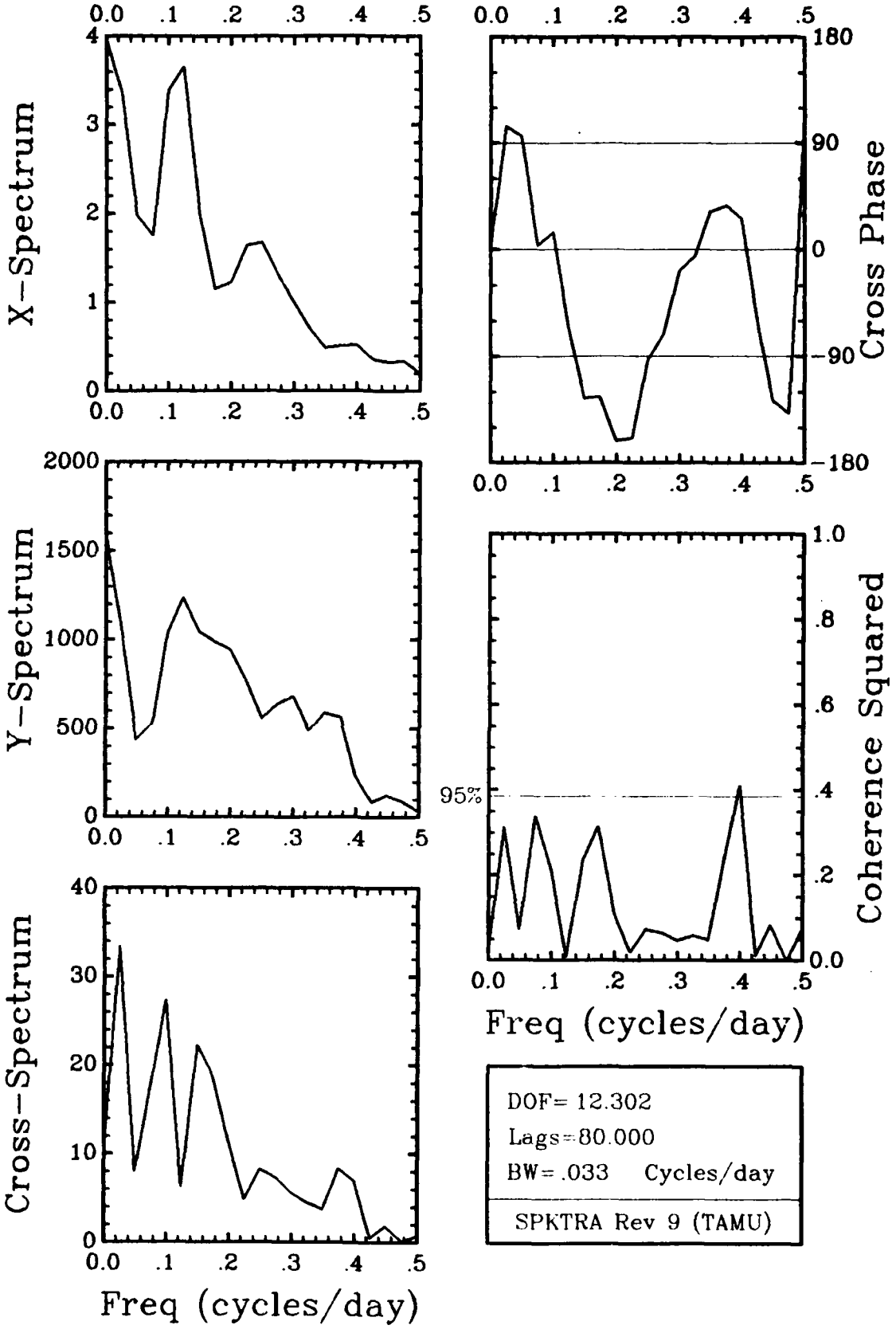
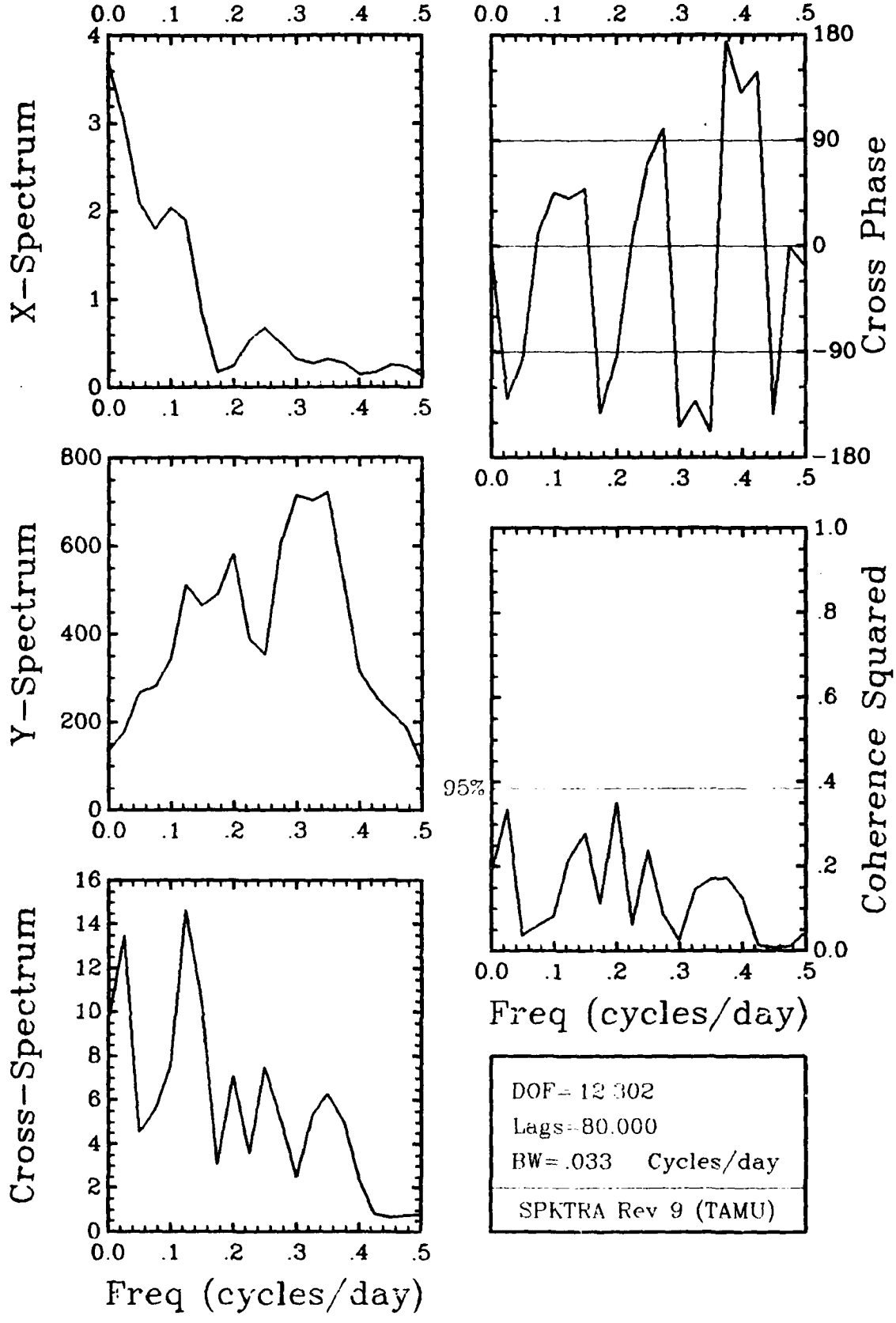


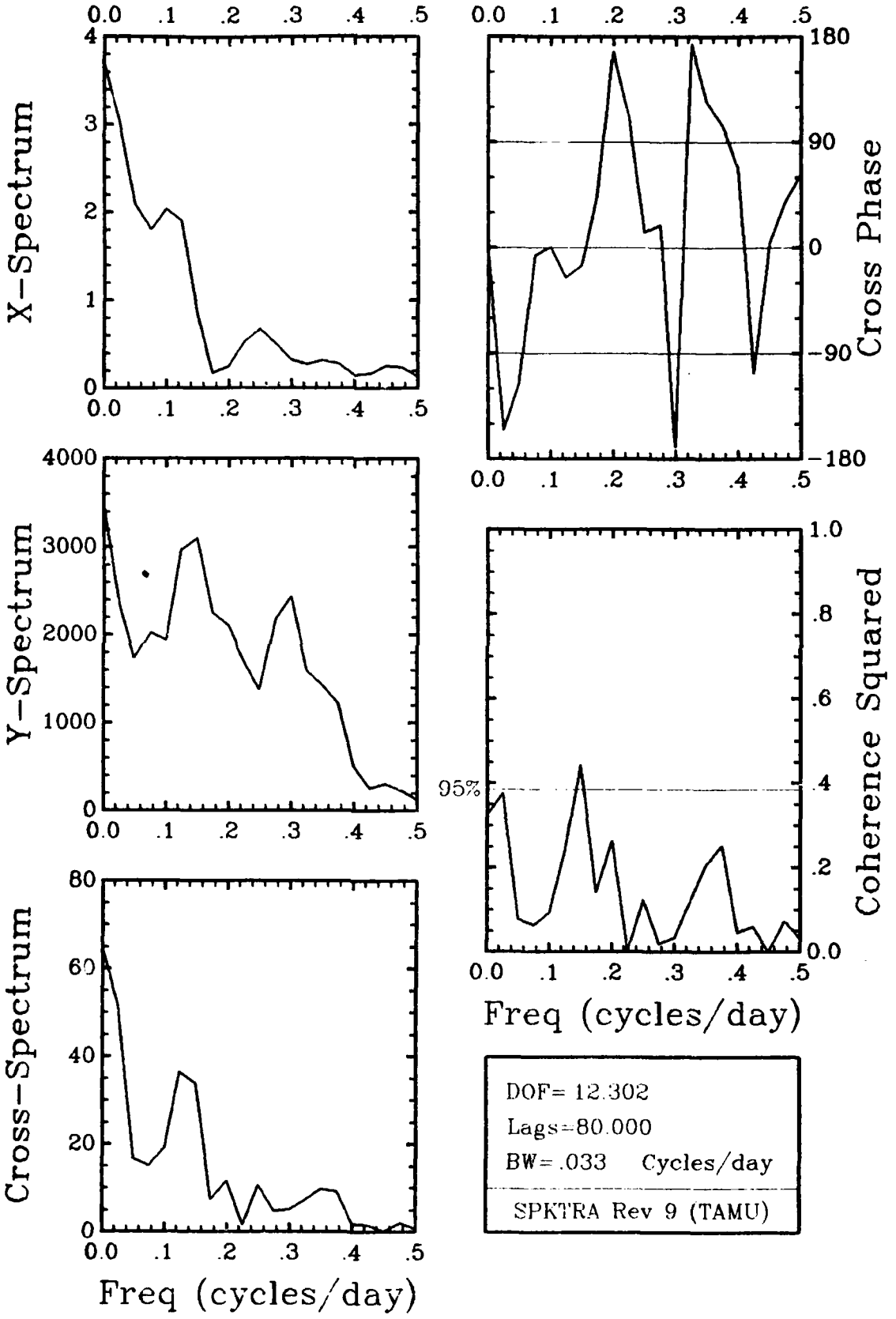
V-Stress$_{41002}$ / B_BU Summer 40 HR LP



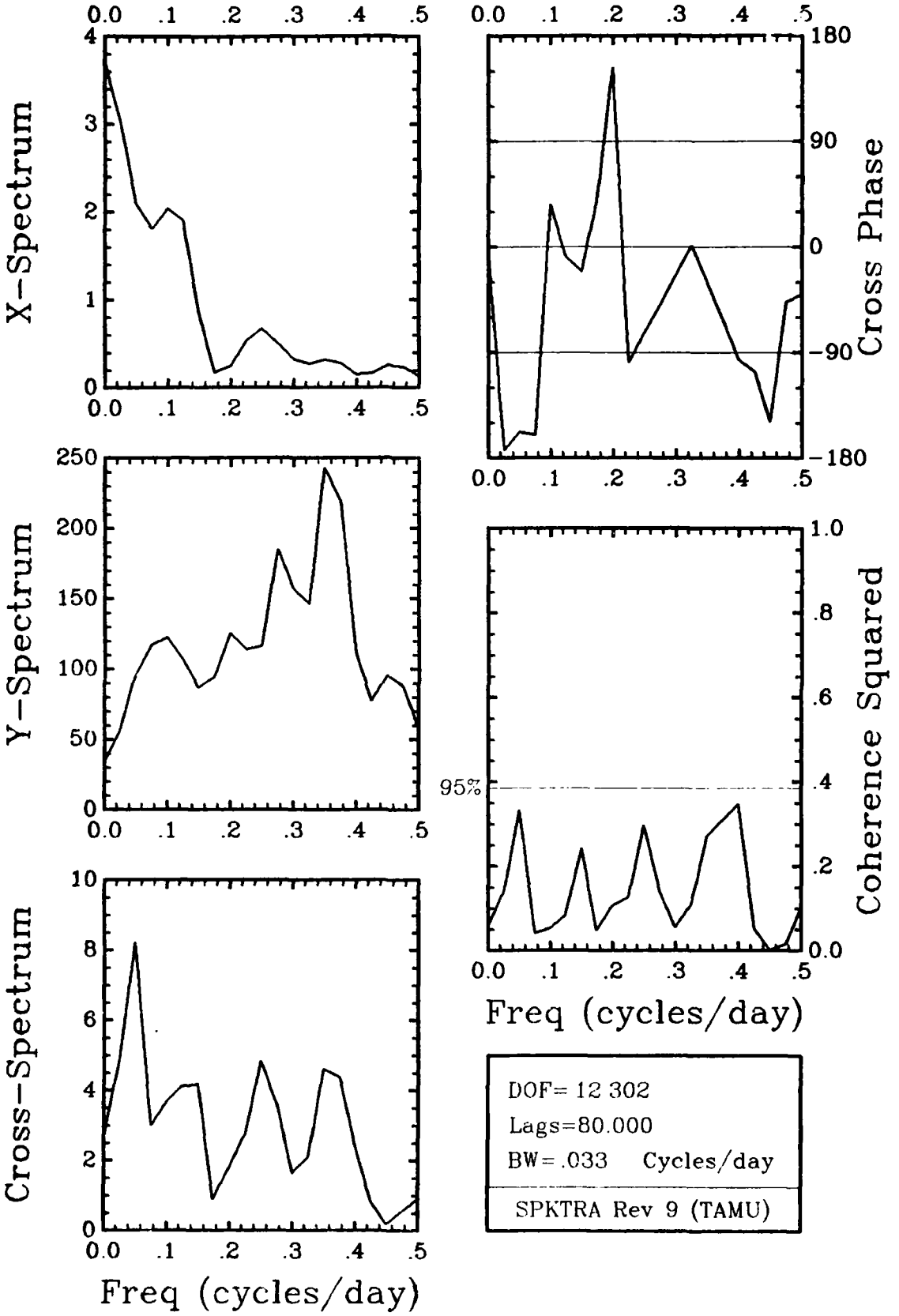
V-Stress$_{41002}$ / B_BV Summer 40 HR LP



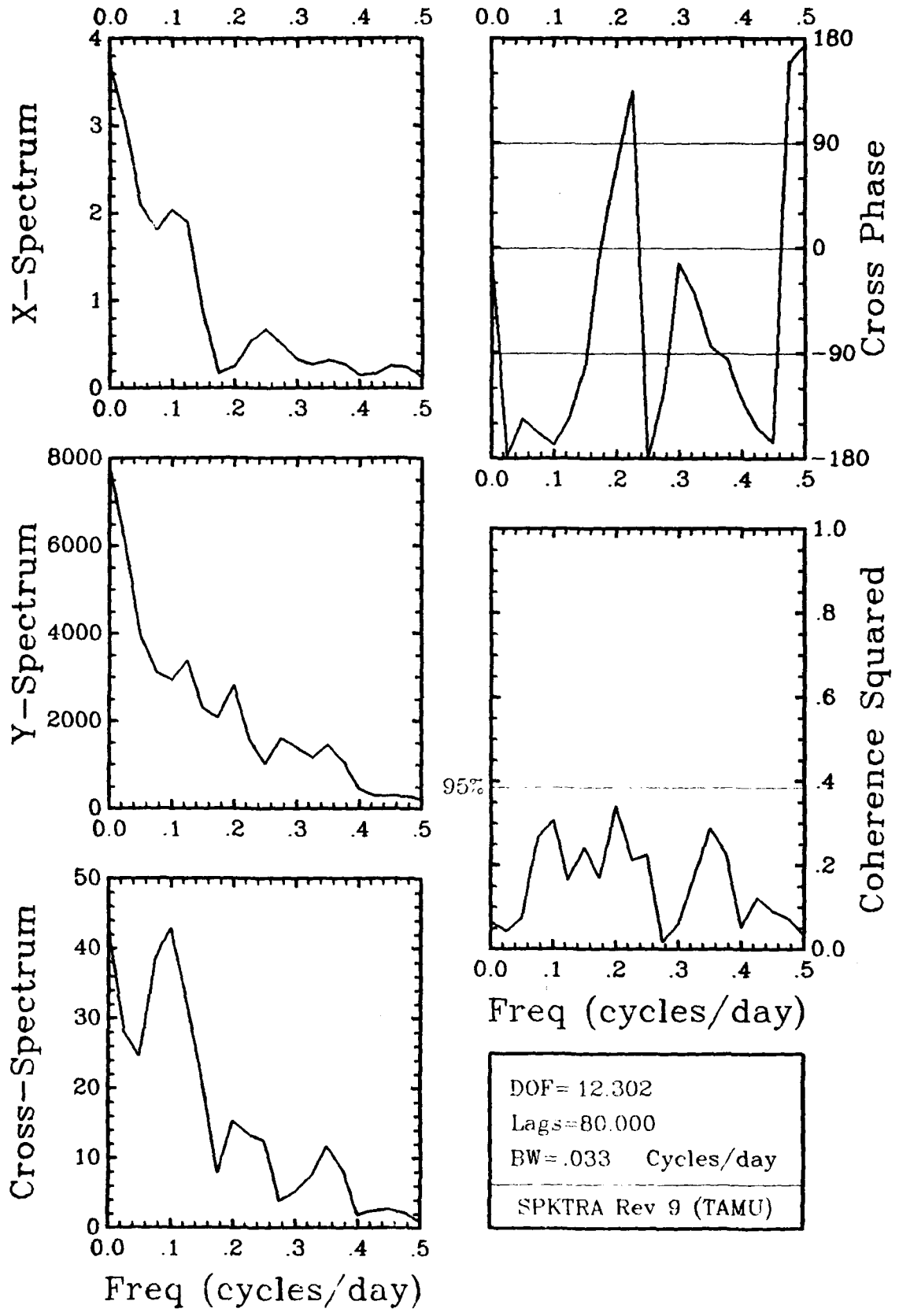
U-Stress$_{41002}$ / B_TU Summer 40 HR LP



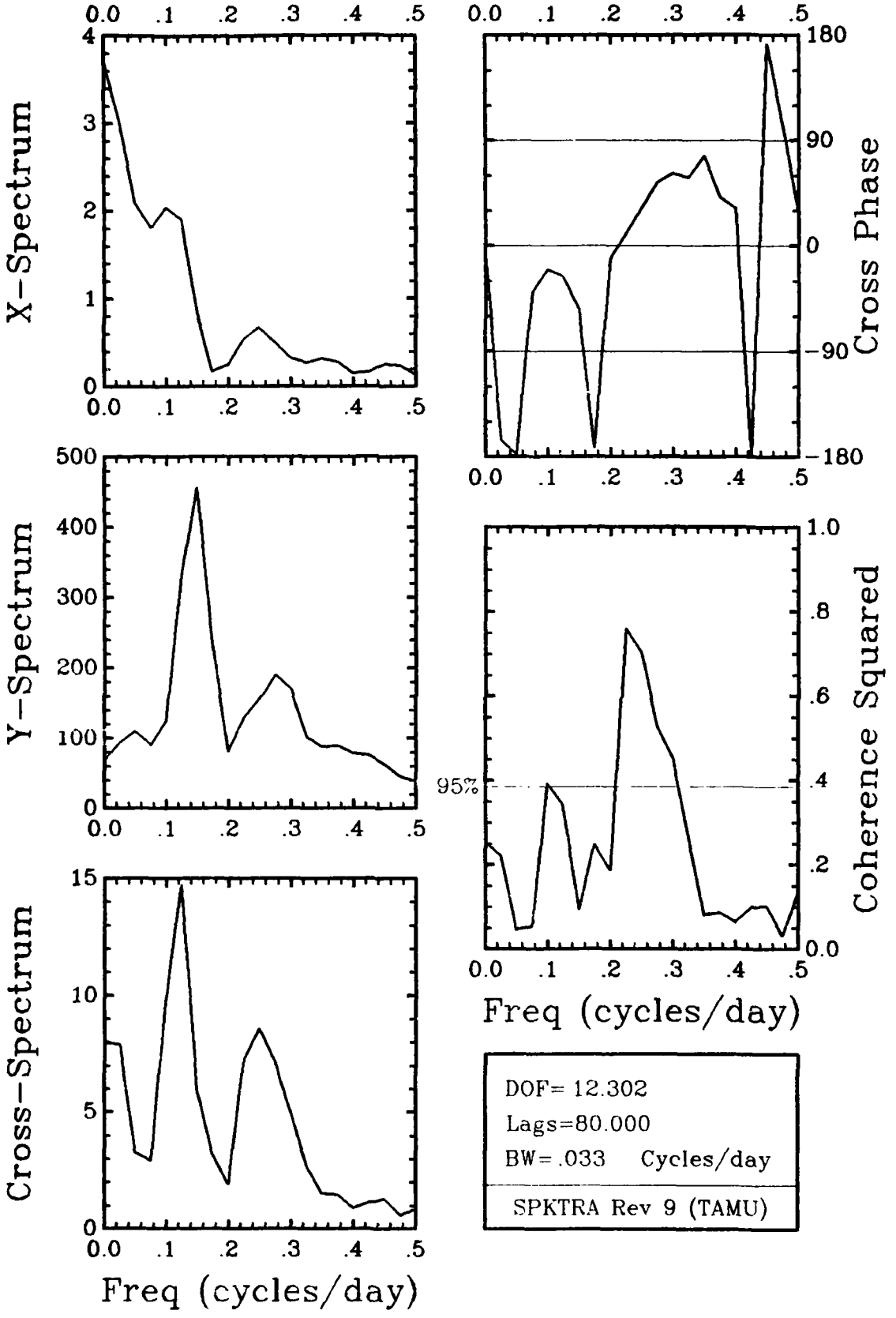
U-Stress$_{41002}$ / B$_T$V Summer 40 HR LP



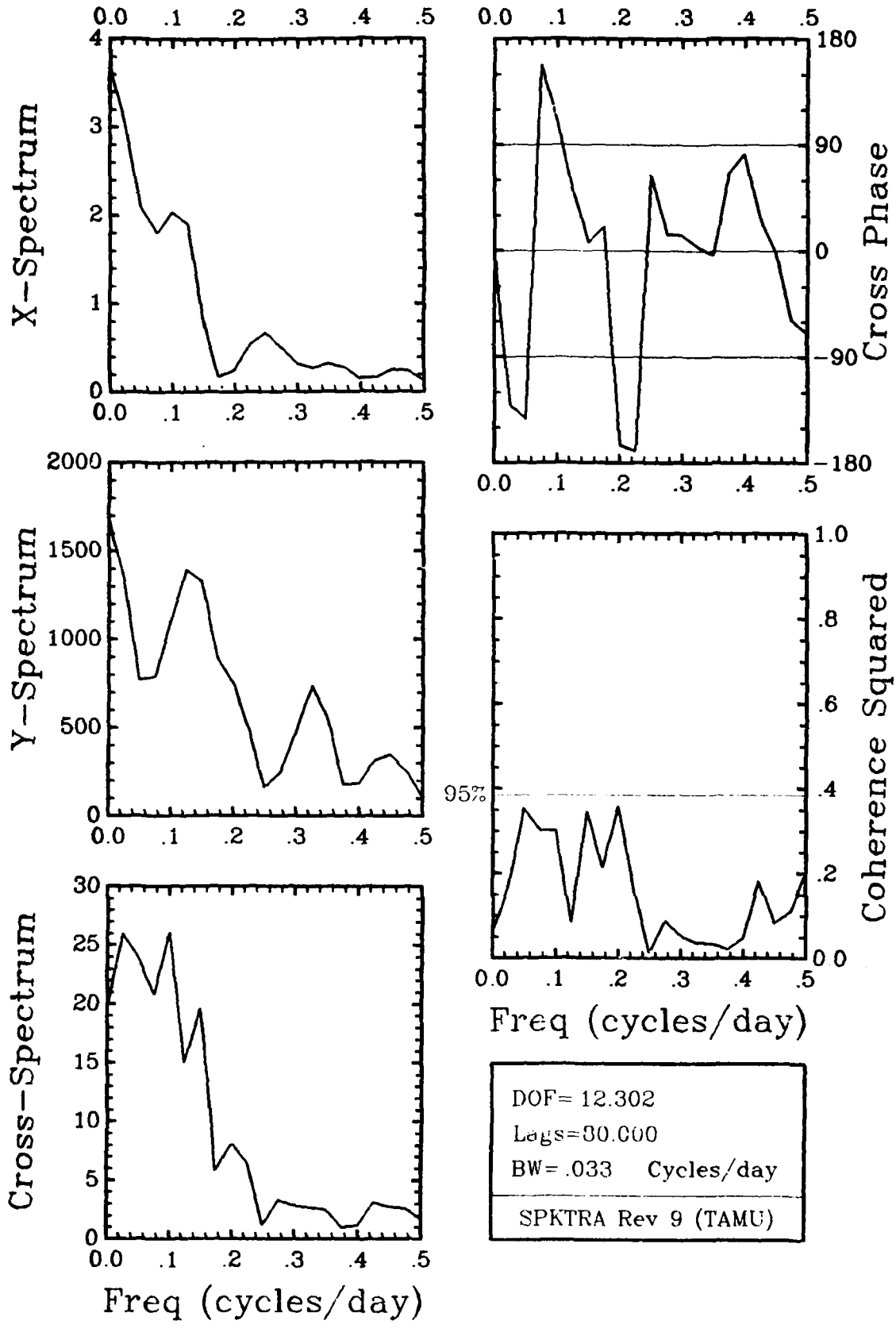
U-Stress$_{41002}$ / C_TU Summer 40 HR LP



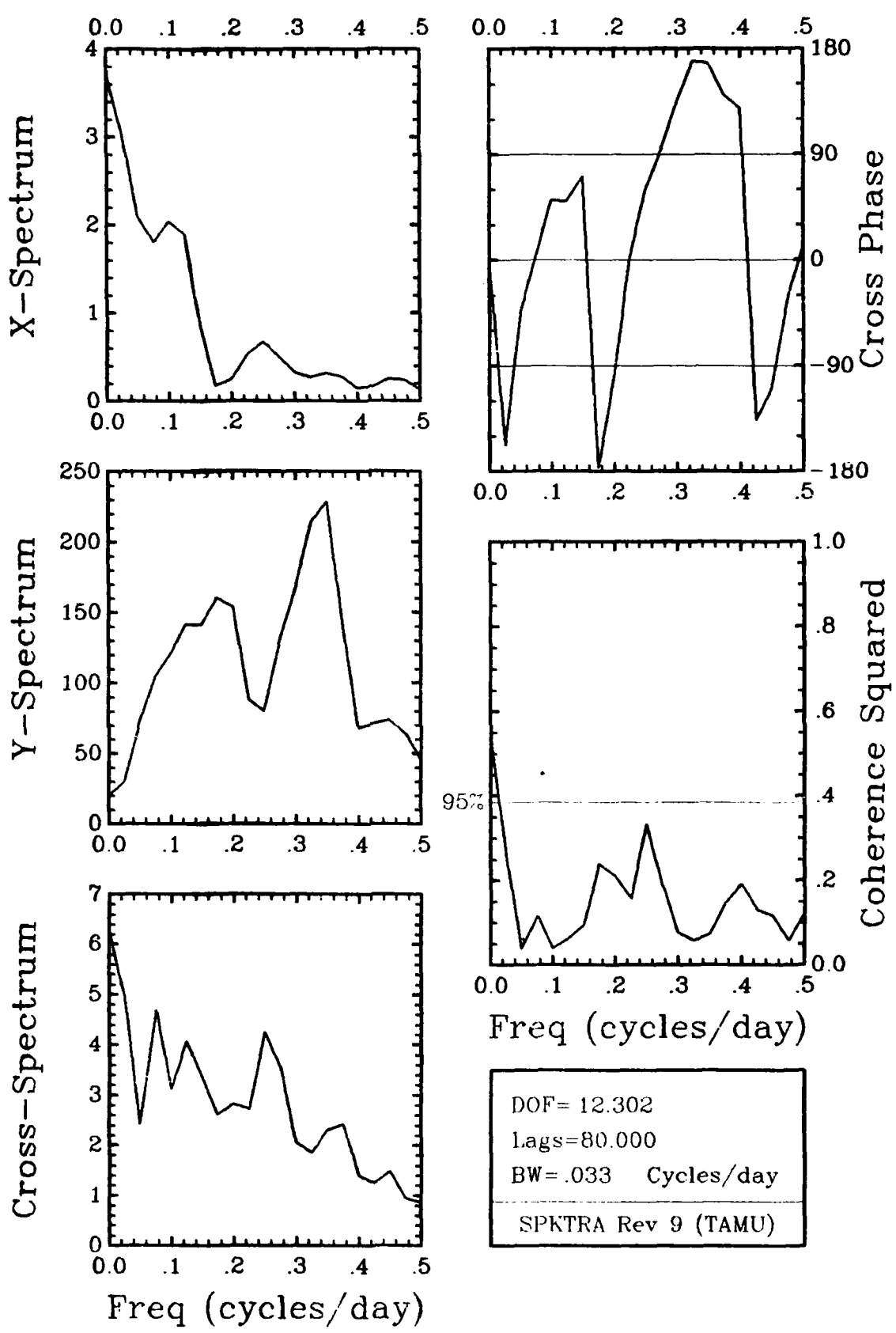
U-Stress$_{41002}$ / C_TV Summer 40 HR LP



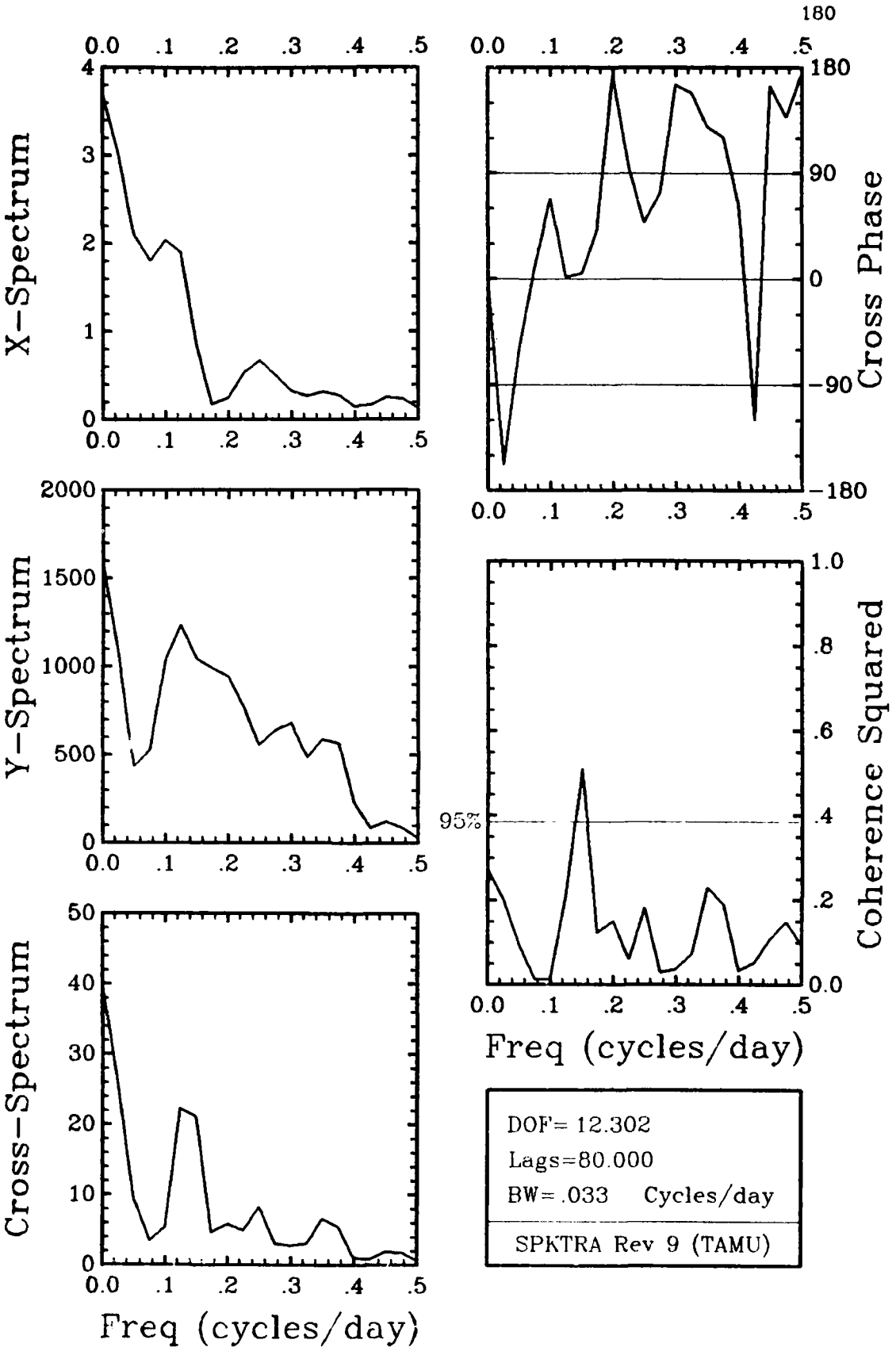
U-Stress$_{41002}$ / A$_B$U Summer 40 HR LP



$U\text{-}Stress_{41002}$ / A_BV Summer 40 HR LP



U-Stress$_{41002}$ / B$_B$U Summer 40 HR LP



U-Stress$_{41002}$ / B_BV Summer 40 HR LP

Acknowledgments

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AD-A103 487 NORTH CAROLINA UNIV AT CHAPEL HILL F/6 8/3
THE GULF STREAM MEANDERS EXPERIMENT. CURRENT METER AND ATMOSPHE--ETC(U)
MAY 81 D A BROOKS, J M BANE, R L COHEN N00014-77-C-0354
UNCLASSIFIED NL

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